

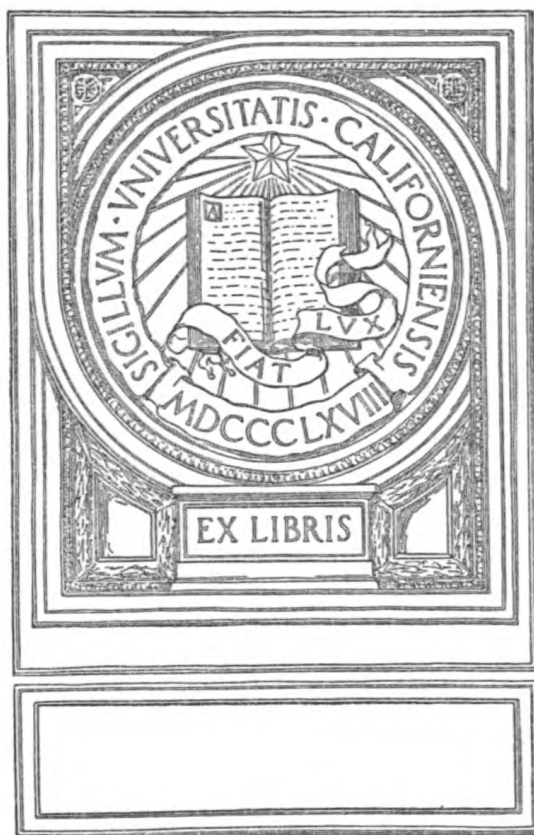
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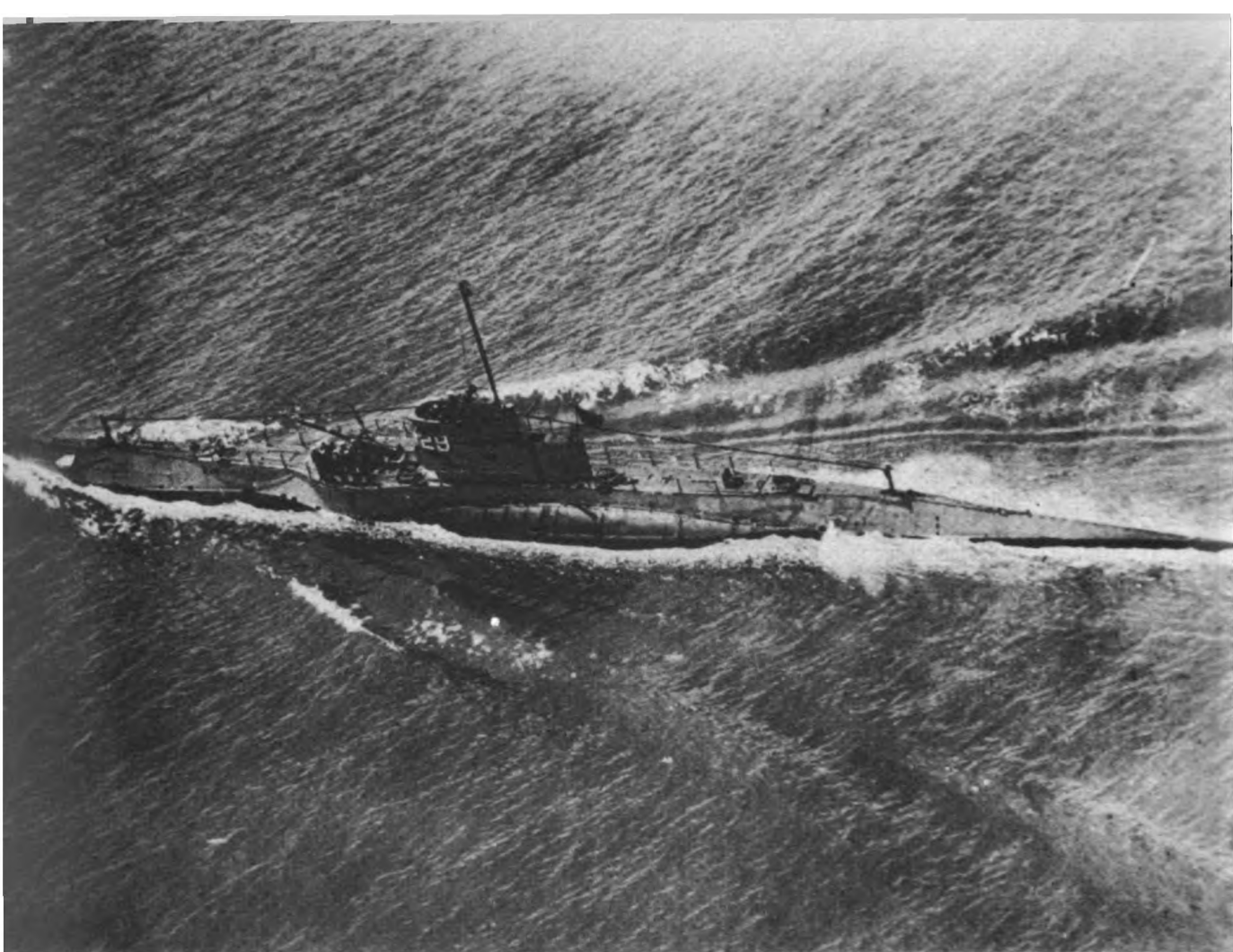
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HE'S IN SUBMARINES NOW

BY HENRY FELSEN



HE'S IN
SUBMARINES NOW



A training submarine, with a group of students aboard, noses into Long Island Sound for a series of training dives.

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By

HENRY FELSEN

"

*Pictures courtesy United States Navy
and Martin Sheridan*

DAY OF
SUBMARINES



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HE'S IN SUBMARINES NOW

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TO VMLU
AIRBORNE

**To
Kirk Stearns
A Submarine Sailor**

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ACKNOWLEDGMENT

I WANT to express my thanks to the many officers and men of the United States Navy who gave me information, answered my questions, and checked the contents of this book; and to the U.S. Navy Recruiting Bureau for the use of official photographs.

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HE'S IN
SUBMARINES NOW

INTRODUCTION

AT SOME POINT IN AL-
most every news broadcast, every day, the commentator reads a bulletin which, with some variation, runs as follows: "Washington. A medium-sized American freighter has been torpedoed off the southeast coast of the United States, according to information released by the Navy Department. Survivors have been landed at an unidentified eastern port."

We hear it every day about American, British, Dutch, Norwegian and Russian ships. In the Axis countries, the public isn't given details of their own sinkings, but if they were, the radios of Berlin, Rome and Tokyo would also be busy reading off the lists of merchant and warships that have gone down before the torpedoes of Allied submarines.

The oceans are alive with submarines. Hundreds of the undersea craft, threading their way below the surface, are on the prowl. Flying the flags of every nation, they hunt with one grim purpose—to seek out the enemy and send him to the bottom.

Submarine commanders are never fools, but submarines often rush in where battleships and even aircraft fear to tread. They are the Indians of the sea, slipping noiselessly

into the heart of the enemy camp, to scout his strength and position, to strike a quick blow if necessary, and to return.

Most of the time, the submarine plays a lone hand, acting as scout and raider. It sends merchant ships scurrying like sheep before a wolf, and even the fighting surface ships, no matter how many times they outnumber a single submarine, can be thrown into disorder by the presence of one lurking pig boat.

A stirring example of this was recently shown by an American craft operating in the Pacific Ocean, during the battle of Midway Island, when a Japanese fleet was given a mauling by an American force. It not only proves how one submarine can upset a surface force, but also that for plain bravery, coolness under action, and skill, American sailors are right up at the top of the list.

The boat received word at dawn that a large formation of enemy planes was heading toward Midway Island. Upon receiving this information, the commander altered his course to seek out and intercept the enemy carriers, on which the Japanese raiding planes were based.

In the distance, a Japanese carrier was steaming at full speed, zigzagging furiously, and sending up a hail of anti-aircraft fire at the American planes which were dropping their eggs all around it. This looked like real action, and the submarine set out for the scene of action.

Peeking out with its periscope again, the dauntless boat saw a great pall of smoke on the horizon, and followed it. Coming closer, they saw it to be a carrier of the Soryu class, a 10,500 ton ship, limping away, closely guarded by two cruisers.

After taking the trouble to find the carrier, the sub com-

mander didn't want to sit by and watch it escape. Cruisers or none, he decided to attack and send the carrier to the bottom. Accordingly, the commander worked into position, and let loose a torpedo, which struck squarely into the carrier.

It would take a larger book than this one to tell of the thrilling exploits of American submarines in this war. Most of them will not be revealed until the war is over, but the few that are released give some picture of the daring of their crews.

It was a submarine that ran a blockade of Japanese ships to bring a fortune out of Manila, when the Japanese were eager to get their hands on that fortune. It was in a submarine that Admiral Hart went through the dangerous enemy waters to take his command in the Far East. And recently another American submarine made a spectacular rescue in enemy waters that defies the imagination of fiction writers.

A group of Australian fliers were forced down on Timor Island, which is under Japanese control. While Japanese patrols hunted for them, the Australians retreated into the wildest part of the jungle. But although they were free, their situation was desperate. They had no food or water, and no way of getting any. They were injured and weak, but they held out in the jungle, preferring to die there than be captured.

Their plight became known to Allied headquarters, and it was decided to attempt a rescue. Planes or surface craft would be spotted, and were out of the question. Only a submarine had a chance of making contact.

Then, one night, when thick low clouds obscured the moon, the rippling waters of the Pacific were split apart

by the lean wet nose of a surfacing submarine. Sleek and glistening, it slid into view and quietly approached the island. Then it stopped. A young officer came out of the conning tower. With the aid of some of the crew, he inflated a rubber boat, and pushed his way silently to the densely matted jungle shore of the island.

Once on the island, the young ensign had a seemingly impossible task ahead—to escape the Japanese, find the Australians, and convince them he was a friend.

The officer struck out into the jungle, knowing the approximate location of the hiding aviators. Pushing his way through the heavy undergrowth, in utter blackness, he needed a strong heart and a steady head to carry him along.

Finally he found the Australians and let them know he was their friend. With the weak aviators following, hardly able to walk, the naval officer led them back through the jungle to the shore, where he helped them get into the boat.

The fliers were so weak that two of them fell out of the boat, but the officer got them back in again, and was soon back at the submarine with the men he had set out to find.

The men were quickly brought into the sub. Then it backed away, turned, and gently slid under the water, making its way back to friendly territory again, after having taken the Australians away from under the noses of the Japanese army.

These few episodes out of the whole story of American submarines help to explain why there are so many volunteers for undersea duty.

Submarine duty is dangerous—there is no doubt about that. The very act of submerging has many elements of

risk, even in peacetime. But danger has never been a bar to young Americans. If anything, it is a stimulant. Where there is the most risk and the greatest danger, there you will find the most volunteers.

The kind of young men who stow away to get to the front sooner, and who are eager to get in a telling blow against America's enemies—these are the men you find volunteering for submarine duty.

Because much of the effectiveness of undersea warfare depends on secrecy, little has been revealed of where and what American submarines are about. And submarine sailors, knowing their lives depend on secrecy, are close-mouthed when it comes to talking about their work.

But sometimes they can be seen, when they have returned from long weeks of sea raiding in enemy waters. Many wear beards which they have grown during their lengthy vigil and, if the day is bright, they may also be wearing dark glasses. Such glasses aren't worn to hide the sailor's identity, but to protect his eyes.

When out, a submarine seldom dares come to the surface during the day. As Benjamin Franklin once said, all cats are gray at night. And all pig boats, seen sliding through the water, also look alike, regardless of nationality. And as they usually operate in enemy waters, they try to remain hidden as well as possible, coming up at night to get air and recharge their batteries. As a result, the submarine sailor seldom sees daylight when he is at sea, and his eyes aren't used to the bright sun.

These men, if you have seen them, are the men who have lain in wait in Tokyo harbor, and sunk Japanese ships almost in sight of the Emperor's palace. They have harried the Japanese supply lines and sunk their warships. They

have carried the war across the Pacific to the doorsteps of the enemy, and made it real.

But courage, no matter how great, is not enough to make a good submarine man. The undersea team must be good, and to be good it must be trained thoroughly, and that is where the Submarine School comes in.

To the school come the volunteers who are gathered from the Navy ranks all over the world. They are the men who have felt the lure of submarine work, and who want to serve on pig boats more than anything else in the world. For most of them, submarine duty is not considered something temporary, or a pastime. Once they are in it, it holds them as long as they can stay. It has a fascination that never loses its power. Navy men who have grown gray in the submarines, and who are in other posts, never forget their beloved pig boats. At the mention of these craft their eyes light up, and they remember a hundred stories of their undersea past.

Once pig boats get into a sailor's blood, they are there to stay. He knows that there will be long weeks at sea in close quarters, that he will be hunted mercilessly by the enemy and that danger will sit at his elbow every minute he is at sea.

But submarine warfare is the sea frontier of the present. It offers thrills and excitement, and important fighting for America. It is a continual game of hide-and-seek with the enemy, a matching of skill, brains and courage. It presents a challenge to the spirit of young Americans that has never gone unanswered. It is a job for men who are tough on the inside, but outwardly quiet.

Daily, American submarines, manned by dauntless

American crews, slip out of port at dawn, to disappear in the fog and mists, to conduct their fight on and under the wide, silent sea. The making of such submarine sailors is described here to the extent allowed by the authorities in charge of that training.



Martin Sheridan

A young sailor checks in at the Submarine School at New London, Connecticut, to begin his course of study that will graduate him as a capable submarine sailor.

Chapter One

PRELIMINARY TRAINING

IT IS EARLY MORNING in New London, Connecticut, and the small city is living up to its name. A thick fog has moved in from the sea to hide the buildings in mist, and only a few lights blink dimly through an occasional window.

The mournful, throaty sirens of boats on the river and in the harbor rasp and beep over the gray water, and the throbbing of some invisible motor is heard. Choppy waves work in to slap at wooden pilings and piers.

The main street of the town begins almost at the river, where the railroad station and tracks are close to the water. From there the street climbs a little hill, flanked on either side by old hotels, and buildings whose architecture is reminiscent of a day when clipper ships spread their sails at New London and bowsprits poked high over the docks.

At this hour the town seems deserted, with only wisps of fog straggling up one street and down another as the wind pushes them. It is truly a morning of the sea, and only one of many like it to the men who have tasted the salt spray of the seven seas.

Halfway up the hill from the waterfront, a group of young men in the uniform of the United States Navy lean against the side of a building. Their sea bags are at their

feet, and their white hats are at every angle. The glow of a few cigarettes shines in the mist, and the sailors talk in low tones.

A short, powerfully built sailor turns to another who is very young, tanned, and with deceptively mild blue eyes. "Where you from?" the short one asks.

The young-looking sailor tosses away his cigarette. "Pearl Harbor."

The short one shakes his head in admiration. "Saw all the fireworks, eh?"

"Plenty. I've been in Chicago the last couple of months. Signal School."

I've just gotten my rating as third-class shipfitter," says the short sailor. "Then this came up and I volunteered."

"So did I. Always thought the subs would be interesting. In Pearl Harbor the sub men were treated like kings when they came back from a cruise. Hotels, good meals. I'd like to try some of that myself."

A tall, thin sailor who has been listening to the conversation breaks in. "These guys on the subs don't have a picnic. I saw them while I was on convoy duty around Iceland. But I figured I'd like to try. That's why I volunteered."

A gray bus roars out of the mist and pulls up before the sailors. They make out the sign "SUB BASE" on the front. "That's us," grunts a sailor. "Let's go."

They pile into the bus, and a few minutes later it swings through the New London streets and heads for the Submarine Base.

The sailors in the bus are new students at the Submarine School. Every man there is a volunteer, because

that's the only way a sailor can get into submarine service. No one is ever assigned.

Although they are new students, they are not new to the Navy. Before he can be accepted by the Submarine School, a sailor must meet one of two qualifications. If he is a seaman or fireman, he must have had at least six months' sea duty on surface ships. Otherwise, he must come from one of the service schools or training stations. Graduates from the schools which turn out shipfitters, machinist's mates, electrician's mates and so on, are qualified as such as soon as they receive their third-class rating.

Any qualified sailor who wants to volunteer for submarine duty makes an application through his commanding officer. It is then passed on to the Bureau of Naval Personnel, with the opinion of the commanding officer. The Bureau makes the final decision on whether or not the applicant seems fitted for submarine duty.

A number of factors are considered. Because of the specialized nature of submarine work and the unusual conditions under which it is performed, everything about the applicant is noted—his ability, temperament, general attitude and physical condition.

Being passed by the Bureau is only the first step. No one can really tell whether a man is cut out to be a submarine sailor until he is actually in training, and until he has gone under. But the large majority of men passed by the Bureau do become submarine men, which speaks well for its ability in judging men.

A typical group of students arriving at the Submarine School will be a good cross section of the Navy. It will contain men who have seen much sea duty, and who have

smelled the smoke of battle. It will also contain men new to the Navy, who have gone through Navy technical schools or training stations. Their first taste of the sea will be in a submarine.

The bus carrying the new students grinds its way through the crooked New London streets, and heads away from town. Swinging onto the highway, it roars along the road that winds along the river.

In a few moments the sailors are passing through peaceful Connecticut country where there is no sign of ships or guns. Frame houses nestle under trees, and cows graze peacefully on the hillsides. The sailors look out at the country scene and then look at one another. This isn't exactly what they expected to see.

A few miles out the bus swings around a curve, and the Submarine School pops up suddenly out of the hills and along the river. The first thing the new students see is a submarine in dry dock. Completely out of the water, the submarine, all by itself, looks as big as a battleship. The sailors look at it curiously, and try to imagine what it would be like to be inside.

The bus goes on, past big buildings, where great stacks of supplies and equipment stand near the railroad tracks. Crates containing hundreds of large bottles of distilled water for submarine batteries are piled near one building, and submarine duty suddenly seems close.

At the same time the sailors get a glimpse of a number of submarines at the docks. In a brief glimpse of the after part of the subs, they look like the fat, stubby tails of giant whales lying at rest. For a moment a submarine comes into



A group of students leave the main classroom building of the Submarine School. In the foreground is an old torpedo—a grim reminder of the purpose of the school.

full view, looking sleek and long, with periscopes jutting above the curved conning tower.

The Submarine School is housed in a neatly landscaped group of new buildings on a hill overlooking the Submarine Base, which is along the river. The training in the weeks to come will alternate between the school and the base, depending on what is being done.

On the base grounds, the new students see a tall tower, looking like a lighthouse, with a covered stairway winding up around the outside. They know it to be the escape tower, and every man has a queer feeling in the pit of his stomach as he wonders about making the practice escape from one hundred feet.

Upon arriving at the Submarine School, the new men report to the personnel office, and then to the officer in charge. They are assigned to places in the barracks, and given a set of instructions which outline base and school.

The school reminds one of a small, well-kept college, except for the presence of armed guards at the gates and the fact that the students all wear the uniform of the United States Navy. The barracks are only a short distance from the classrooms, and are also solidly built red brick structures, with ample window space, neat bunks and plenty of space for the students' belongings. A number of very businesslike swabs (mops) are stacked neatly outside the main doors, and the barracks, like all the other buildings and equipment, are spotless.

In front of the main building is a large naval gun, which is kept polished and shining. On the lawns are two torpedoes of ancient vintage, which serve as a reminder of the primary purpose of the submarine in modern war.

Although the student is given a physical exam before

he leaves his old post in the Navy to come to the Submarine School, he is given a physical when he arrives at the school. It does not vary greatly from the regular physical examination, except that it is stricter. Heart, lungs, sight, reflexes, nose and ears must be up to the perfect mark. In height and weight the student must be neither too large or too small. Practically all submarine men seem to be of medium size, although there are a few who are taller than average. The tall ones, an officer explains, just have to stoop over more.

Space in a submarine is limited, and everything taken aboard must be efficiently packed—even the crew. Outsizes would have difficulty in living under such conditions. Also, every pound of weight, one way or another, is important. Too much beef on the crew means a reduction in the amount of food, fuel or ammunition to be carried. And it's easier to reduce a sailor than starve the guns.

The first week or so that the student is at the Submarine School he does not have any classes. There are further tests to be made before it is finally decided that he is qualified even to receive instruction. First on his list are the pressure tests, the escape tower, and gas mask instruction.

There is a good reason for giving these tests first. If the student has some hidden defect that will not allow him to stand pressure, or if he cannot complete a practice escape, that must be found out before he has taken the complete course of instruction, and before he is allowed to go down in a submarine. If he cannot do these things, he's just out as far as submarine work is concerned, and he'll have to find some other branch of the Navy to work in.

The pressure chamber and the escape tank are unknown experiences to the new students, and as such, hold vague

terrors. The students who have already taken and passed these tests consider it their unofficial duty to fill the new students with blood-curdling reports of what will happen, but the new men have been in the Navy long enough to know how to take it.

It is still a day of dry throats when the first pressure tests are due. After breakfast the students report at the escape tower along the river, and are ready to take what comes.

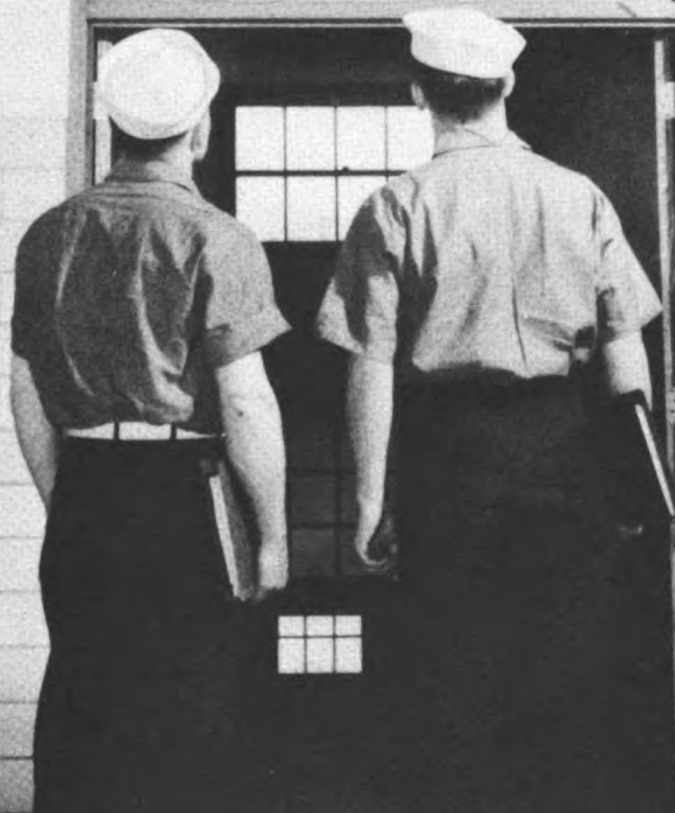
They report in dungarees, kidding with each other and eying the equipment they must soon use. The commissioned officers in charge of the tower are already on hand, dressed in striped trunks, and wearing white terry cloth robes. The chief petty officers who assist in the instruction are dressed the same way. In a corner of the office, a radio is turned to the morning news. Everyone lends an attentive ear to the announcer as they go about their duties. A plaque on the radio reads, "To the Personnel of the Submarine Escape Training Tank in Appreciation. National Broadcasting Company."

The students undress and put on swimming trunks, standing around looking things over. A few study the Momsen Lungs that are on the wall. Others look at the pressure tank, which fills a large part of one room.

Suddenly, from outside, there is a loud, harsh sound, like the greatly magnified bawl of an angry bull. The students look out and see one of the submarines backing into the river. The low gray submarine moves back slowly under the power of its Diesel motors, a great cloud of thick white smoke pouring out of the port side. The submarine backs around until it faces downstream, and slowly moves toward

THEIR WANT OF PRACTICE WILL MAKE
THEM UNSKILLFUL AND THEIR WANT OF
SKILL, TIMID. MARITIME SKILL, LIKE
SKILLS OF OTHER KINDS, IS NOT TO BE
CULTIVATED BY THE WAY OR AT
CHANCE TIMES

THUCYDIDES 500 BC



Two students on their way to class pause to read a bit of sage
advice that has not become less true two thousand four
hundred and forty-two years later.

the sea, its decks almost awash, and the conning tower looming huge and grim above the river.

A husky chief petty officer calls the crowd of students together and takes the roll. Every man in the section is present, and waiting for the test. They are standing in the room at the base of the tower which contains the pressure chamber and numerous other dials and valves.

Standing there, they look like a bunch of healthy young fellows ready for a swim. Tanned, muscular, showing a tattooed arm or chest here and there, they might be taken for a group of college students with their coach. One young sailor has a pig tattooed on his right foot and a rooster on his left. It is a carry-over from the days of wooden ships, when sailors thought such a tattoo would act as a charm to prevent their being drowned.

The Chief finishes calling the roll and puts away his list. The students line up by the chamber, eying it curiously. It is a massive thing, painted gray, about twenty feet long and seven or eight feet high. It is cylindrical in shape, with deadlights at intervals on each side—deadlights being small portholes, in effect.

The Chief opens the hatch and motions for the students to go into the chamber. They stoop over and file in, one at a time, taking their places on the benches that line the inside of the chamber. The Chief comes in last, tossing in a pile of white terry cloth robes. It's hot inside the chamber, and the students wonder about the robes. Inside, an electric light burns brightly, and a small fan hangs in one corner.

The Chief steps in last, dogging down the hatches behind him. Outside, a sailor tests the hatch to make sure it is tightly closed. The Chief faces the students. "You're

going to get fifty pounds of pressure," he says, his voice booming and hollow in the chamber. "If you can take that much, you're all right for submarine work." He hammers a signal against the side of the chamber, and immediately there is the hiss of compressed air rushing inside.

The young sailors sit with their hands on their knees, trying to look unconcerned. But every eye keeps turning toward a big dial at one end of the chamber, where the air pressure is shown.

The air hisses in, and the hand on the dial moves slowly. One pound . . . two pounds . . . The Chief suddenly turns off the air. The hissing stops. The students look at him. Is something wrong?

"We're under two pounds of pressure per square inch," the Chief says. "We're going to take fifty. Two pounds doesn't sound like much. You probably don't feel anything yet. But all of us together couldn't open that hatch against two pounds. It equals about one ton."

The students blink and look at the hatch. Then, as the Chief turns on the air and it hisses into the chamber again, they watch the big dial.

Slowly it moves up. Ten pounds. Fifteen pounds. Twenty pounds.

It is hotter in the chamber. The students have already been told that air heats up under pressure. Now they feel it. The little thermometer hovers around one hundred degrees. The men are glistening with sweat. Their lips are dry.

"If your ears feel funny, try swallowing," the Chief advises. His normally deep voice is thin and squeaky under pressure. The students take his advice, and their ears clear with a little "pop."

The Chief watches his group carefully. For the first time, he is able to see his men under a strain. Their reactions are important. Already, in his mind, the Chief is making notes about different students.

All the students come along well. There is no sign of pain or suffering. No one has a cold, and ears seem good. Anyone with a hollow tooth would have known about that before this. It looks like a good bunch of boys.

The hissing air still pours into the chamber, and the pressure goes up steadily. The needle on the dial creeps toward the fifty-pound mark, and the temperature approaches one hundred and thirty. It's like a Turkish bath inside, and extra fat on one or two of the boys is taking a beating.

Finally the needle comes to the fifty mark and stops. The Chief smiles, takes his mallet, and signals that they are ready to come out. The air begins to "bleed" out at a rapid rate.

The temperature in the chamber falls as rapidly as the air pressure. The moisture in the air condenses, fogging up the deadlights. It feels cold, and the men shiver.

The Chief tosses robes to them, and they gratefully put them on. Even so, it's cold enough to make their teeth chatter. At ten pounds of pressure the needle stops for several moments. The men are being decompressed according to a fixed chart. Even in this test, any variance might result in someone getting the caisson disease, better known as the "bends."

The bends, long the dreaded enemy of submarine men and deep-sea divers, is now kept well in hand by proper knowledge of decompression periods. J.B.S. Haldane, the British scientist who is responsible for a great amount of

the work done to understand the bends, is still conducting experiments in London further to investigate pressure and how to meet it.

Bends occur when a man under pressure is brought to the surface too suddenly. While under pressure, a man's blood is something like capped soda water. If the pressure is released too suddenly, the nitrogen "fizzes" out in bubbles in his blood, and this can have serious or fatal results.

Decompression tables are worked out to a high degree, however, and are rigorously observed. In cases of emergency, where a diver may be brought up too quickly, he can be placed in the decompression chamber, put under pressure and be decompressed properly.

Although every man who works under pressure is taught to understand the bends and knows that the price of carelessness is to suffer them, the bends are no longer the threat they were when men did not have the knowledge or means to combat this foe.

The students in the chamber are further halted at five pounds of pressure before the needle drops to zero, and they have completed their first pressure test.

The Chief swings the hatch open easily and leads his men out. As they come out they turn and look at the chamber. They breathe deeply and smile. Pressure holds one less terror. They have been under fifty pounds and they have come through. It seems not minutes or hours, but years, have passed since they entered the pressure chamber. They begin discussing their experience, joking and making light of the fear they had before they underwent the test. And they are ready for the next step toward becoming submarine sailors.

The next step is the submarine escape tower, where, with the aid of the Momsen Lung, they will make practice escapes from depths of 18, 50 and 100 feet. The ability to make a practice escape is also necessary for every man who has volunteered for submarine duty. Someday his life may depend on making such an escape.

The question of how to escape from a submarine is as old as the submarine itself. The most advanced method of all was developed by the United States in the form of the diving bell; and where the bell can be used, it cannot be excelled for efficiency and safety.

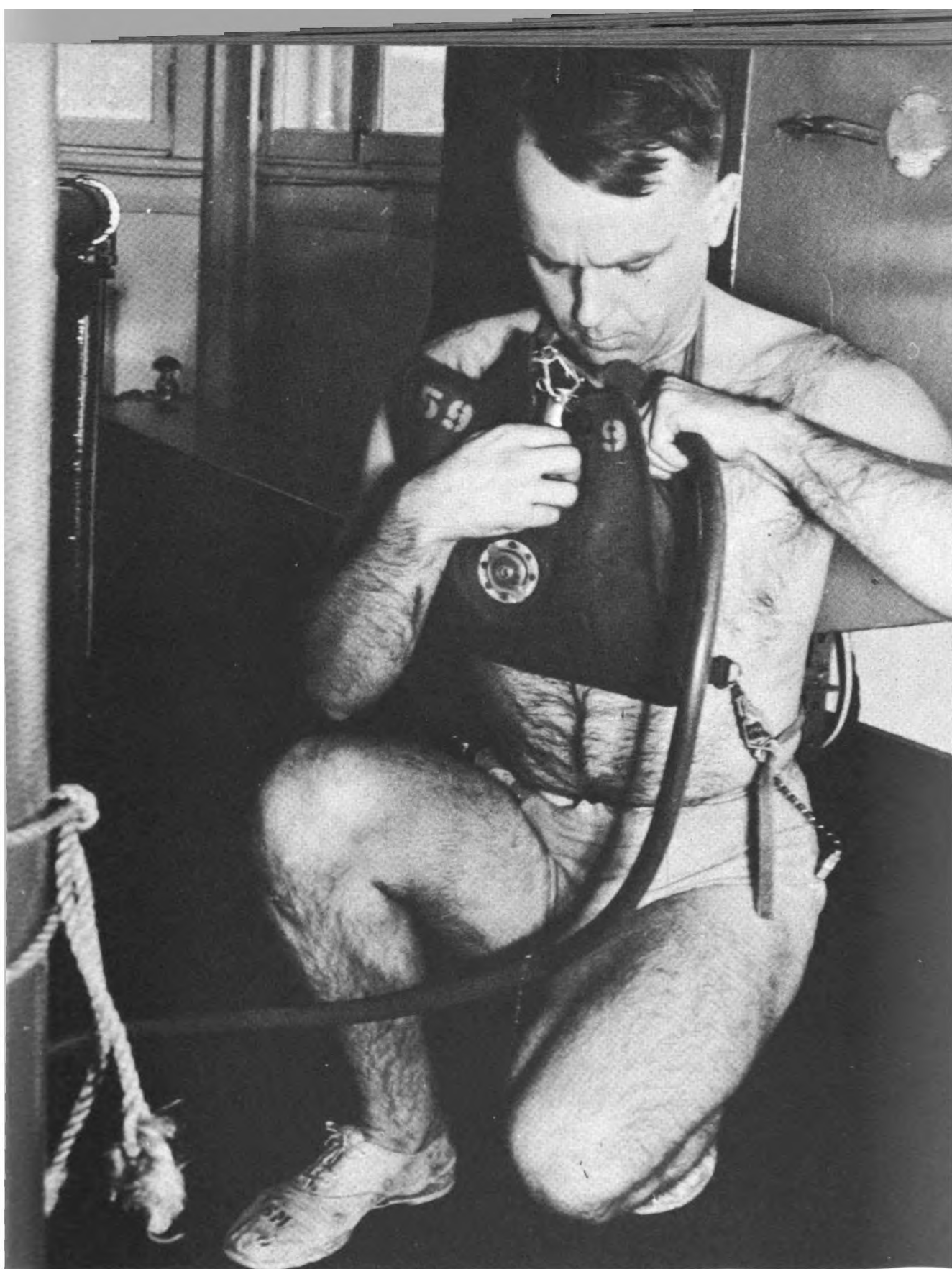
Roughly, the diving bell is a giant metal sphere, which is equipped to keep the pressure inside at normal, no matter to what depth it may go. The bell is lowered from the side of a rescue ship, and fastens on to the hatch of a sunken submarine. When the hatch is opened, the submarine crew can climb out directly into the bell, and ride to the surface.

But the diving bell cannot always be counted on to be around the scenes of action, and many submarine escapes depend on speed. For such cases, the Momsen Lung is the means of escape.

The Momsen Lung was invented and developed by an officer in the United States Navy. It is small, compact and efficient. It is easy to use, and after a few lessons the student is fully at ease with it.

The submarine escape tower at New London rises over one hundred feet in the air. It is, in effect, a tremendous water tank. The student enters at the bottom and makes his way through one hundred feet of water to the top in exactly the way the same operation would be accomplished from a submarine.

The student first makes a practice escape from the 18-



Martin Sheridan

An instructor at the Submarine School checks his Momsen Lung before leading a group of students through a practice escape in the submarine escape tower.

foot depth, then the 50-foot, and finally, the 100-foot depth. The last is the granddaddy of them all, and even though the student has come through his preliminary escapes with flying colors, he's a little nervous when he goes to the 100-foot lock.

Before he goes into the escape tank, the student must undergo twenty pounds of pressure in the pressure chamber. This is just enough to test his ears and nose, and bring out any temporary weaknesses. If he has a cold, he is not allowed to undergo heavy pressure.

The day the students are ready for their practice escape is like the day they first took their pressure test. Again, all are dressed in swimming trunks. The officers check their men, and issue Momsen Lungs, which are put on.

The Lung lies against the chest, and is fastened by a strap that goes around the student's back, and by clips which he attaches to the bottom of his swimming trunks. The Lung has a canister of carbon dioxide absorbent as its heart, and when charged with oxygen has a tendency to float away toward the surface unless held down.

Each student uses the same Lung for all his practice escapes, and while his group gets ready he fastens his Lung securely. Then, under the direction of an officer and a chief petty officer, the students file into the 100-foot lock at the bottom of the tower.

The 100-foot lock is built to reproduce the interior of a submarine. At one end there is a hollow metal shaft which projects downward from the ceiling, like an oversized stove-pipe. The men stand ankle-deep in water, moving around restlessly as the officer in charge sees that everything is in order.

Then the outside hatch is swung shut, and the Chief picks up a telephone to let the men outside know that he and his class are ready. A minute later the water starts to pour into the lock, frothing, bubbling, and roaring like an express train in a long tunnel as it gets deeper and deeper.

The Chief stands at a huge wheel, regulating the inrush of the water, and when the pressure is equalized, the outer hatch opens, and he shuts it off. The level of the water is then at the lower lip of the "stovepipe" mentioned above, and the air trapped in the upper part of the chamber prevents its rising higher.

The students put on the nose clips, put the bits of the Lungs in their mouths. The officer in charge charges each Lung with oxygen, and then each man ducks his head under the water to test his Lung and see that it is working properly. The Chief ducks under the lip of the pipe and rigs the escape line, then swims up to take his post in the bell at the 80-foot level.

After him, the students drop under the water one at a time, and go through the hatch, which opens about three feet above the deck of the lock. Remembering his instructions, the student breathes in and out of the Lung. As he comes up through the hatch, he takes hold of the ascent line, and rises into the main part of the tank.

Coming through the hatch, the student sees that the upper side of the lock is built to resemble the deck of a submarine. It takes little imagination to believe that this is a real escape.

The only departure from reality is the presence of Winnie and Minnie, the two mermaids who are painted on the side of the tower. The student has heard much of

these two, and now, by making the 100-foot escape, he has actually seen them. It's one of the unofficial honors of the submarine men.

The student hangs on to the ascent line, regulating the speed of his rise. Left alone, he would float up too quickly, and the sudden change in pressure might prove harmful. In proper form, he holds on to the line, and allows himself to climb slowly.

Proper form is with the body rigid, and away from the line. The feet are closed against the line, and the hands are extended, with the line passing between the thumbs.

At fifty and at eighteen feet, other instructors are perched in little bells which enable them to watch the progress of the students, and to swim out to give assistance if it is needed.

A student, under the excitement of the moment, hugs his line too closely. The instructor, a chief petty officer, leaves his bell and swims down to the student, setting him right. The instructor has no Lung, but wears nose clips and goggles.

Because the water at this depth is clear and still, it looks as if the instructor were actually flying slowly through the air as he descends, his arms waving, like a large, round, hairy-chested cherub.

One by one the students come up. At the top of the tower, other instructors swim around and wait for them. A yellow buoy marks the line where the students are coming up. A sailor stands ready to check each by name as he comes up, and report on timing.

In the top of the escape tower it is hot. The windows on all sides are covered with moisture, but the men can look out and look down on the great Submarine Base. From this

height the river looks small, and the submarines along the docks seem very tiny.

A tug on the line announces that a student is coming up. The instructor swims down to watch him come to the surface. As soon as the student is up the instructor says, "Close your valve."

The student takes off his nose clips and shuts the valve on his Lung, then swims for the side of the tank, being careful not to kick too violently with his feet, in case there is another student close behind him.

Soon the entire group has come up. The students stand around and chatter with each other about their experience, asking about their timing and their form. When they are all up, the instructors take them down in an elevator, and prepare to issue them certificates.

Every student gets the certificate when he makes the 100-foot escape. It is unofficial, although it is signed by the officers in charge of the tower. It is mimeographed, with the likenesses of Minnie and Winnie at the top, and it tells the world that on such a day the sailor mentioned made the 100-foot escape. It means that he has passed one of the biggest tests that face the prospective submarine sailor.

Done correctly, there is no danger in making practice escapes, and thousands of men have come through without a mishap. But the procedure is as strict as though the men were making an actual escape. Horseplay might not be harmful in the tower; but under actual conditions a man who learned his lesson badly would be a threat to his fellows as well as to himself.

This is one of the first places in training where the submarine sailor finds out that the fate of the ship depends on the co-operation and ability of all the men, and

every man's actions can affect the submarine. He finds that submarine work is a responsible job, and that he, as an individual, is important in the operation of the boat.

After he has successfully completed his escapes, the student may go through a period of gas-mask drill. In this, he dons a gas mask, goes into a chamber which is filled with gas, and finds out that he can be fairly comfortable while poisonous fumes drift around his head. It's just another way of helping the student gain confidence in his equipment.

Chapter Two

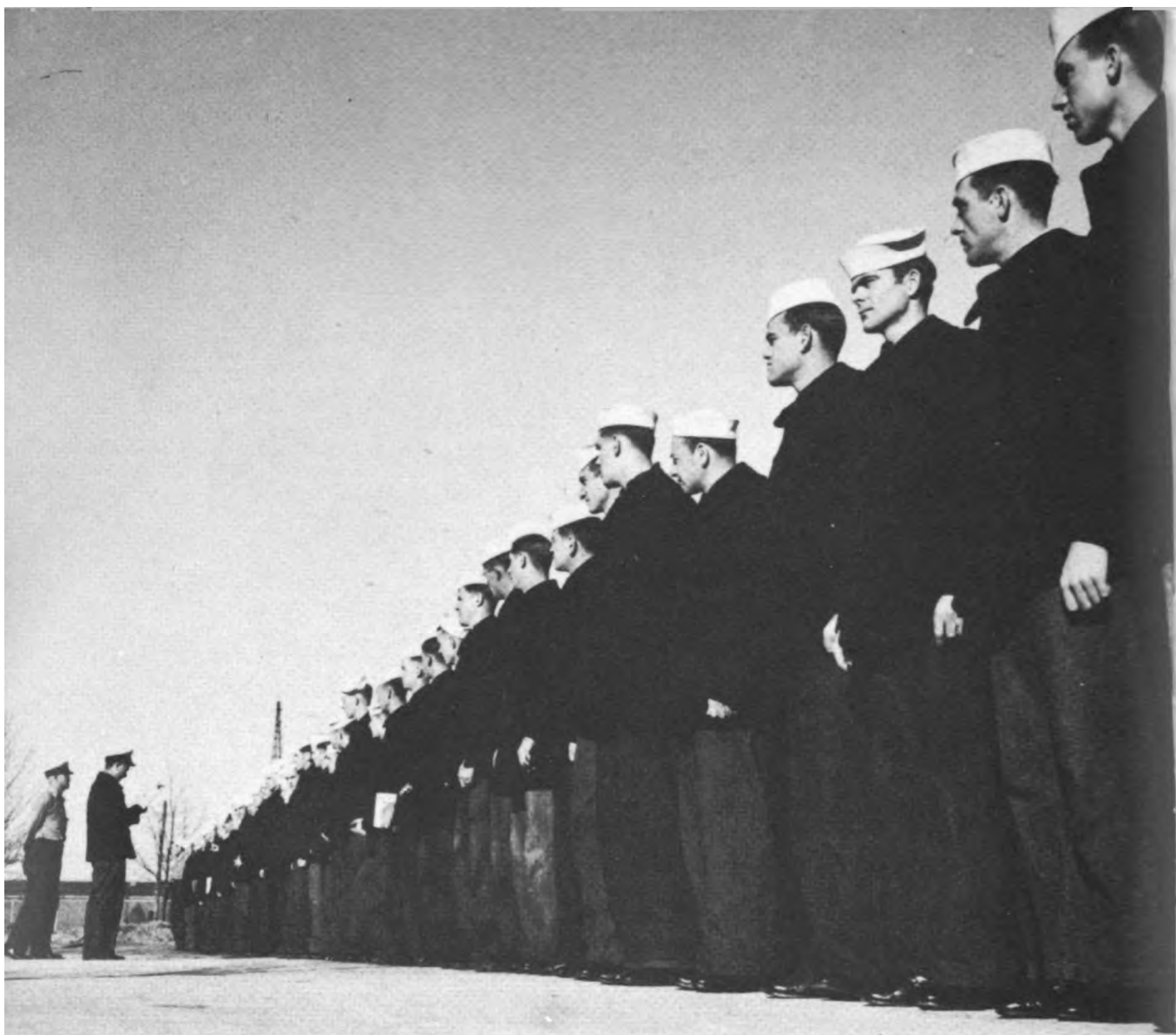
THE TRAINING SUBMARINE

WITHOUT A DOUBT, the most momentous day at the Submarine School for the student is the day he is ready to take his first passage on a submarine. It comes early in the course, starting when the student has been at the school for about a week.

Before he is ready for the first passage, however, the student studies the construction of the boat, so that he will be more at home when he gets on. Later on in the course, every section, every item on the boat will be explained to the student, and he will have taken apart and put together practically everything but the hull.

The undersea boat today differs from early submarines as much as a modern bomber differs from the plane built by the Wright brothers. Yet even the most modern submarine has a number of things in common with the oldest. The theories of submersion and submarine operation are as fixed as are the laws of flight.

John Holland worked out the ideas of the modern submarine while America was still engaged in the Civil War. He developed the idea of the double hull, the system for taking in and expelling water, and later determined the proper places for torpedoes, gasoline tanks and electric motors. And although submarine development has come



Students line up for morning muster at the Submarine School. Some of them will spend the morning aboard a submarine making practice dives, while others head for the classrooms.

far since Holland's time, the basic ideas have not changed.

It is a chill morning when the student eats a nervous breakfast and prepares to spend his first morning on a training submarine. A second cup of coffee hits the right spot on this morning.

After breakfast, the student is ready to report. For the first time he is going to work with the diving section that will stay together all through training and, if possible, in later action.

A diving section is composed of the number of men capable of taking a submarine out, submerging and surfacing it. Usually this amounts to somewhat more than a dozen men, made up of all the ratings that are found on a submarine.

When the fact is mentioned that the crew of a submarine is three or four times the size of a diving section, it should be remembered that one section cannot work for twenty-four hours a day, and a submarine on duty is active for just that many hours.

On this morning, the student finds that in his section are the signalman from Pearl Harbor, the machinist from Iceland, a torpedoman from a destroyer, and others from active service and from schools. The students look each other over keenly at this point. They know that they are being trained as a team, and they want to size up their teammates. They're going to see a lot of each other from now on, and they are going into battle together on some future day. They talk easily, already having some knowledge of one another from the tests they've taken at the escape tower.

The students walk down to the Submarine Base from the school. With them is one of the chief petty officers who



A Chief Petty Officer explains the conning tower to a group of new students. The sailor in the center is holding onto one of the periscopes.

has been assigned to them. Not only does each diving section stay together all the way through their submarine training period, but the CPO in charge stays with one group.

Every chief petty officer at the school has a long record of submarine service. Most of them have been in it for sixteen or twenty years, and have been picked for their jobs because of their experience and their ability as teachers.

Although these men are proud of the time they have served in the Navy, and particularly in submarines, they are reticent about blowing their own horns. They also have a habit of spoofing a credulous listener with such off-hand remarks as, "Him? He's a real pig-boat veteran. He was with John Paul Jones when I was serving under Farragut."

One Chief, who has also had deep-sea diving experience, spun yarns about feeding sharks with tidbits from his hand while working in the Pacific. And he told it with a straight face—as most of such stories are told.

The chief petty officers have the closest contact with the students, being in direct charge of the men, and are responsible for seeing that the students learn their lessons well. They have to be a combination teacher, straw-boss, friend and adviser to the new men.

These chief petty officers, with almost a quarter of a century in the Navy, have all come up the hard way, earning every stripe. They know the Navy inside out, and their sage advice has helped many a youngster find his place in the service of Uncle Sam.

When they put on their coats, most of the chief petty officers in the submarine service seem to have more hash marks than a tiger has stripes. Hash marks are the service

stripes worn on the left sleeve. Each one stands for a completed four-year term of enlistment.

The Chiefs like to joke about the numbers of hash marks they have, invariably running themselves down and talking about someone else as a real veteran of the Navy. "He's got hash marks up one sleeve, under his armpit, and a half a dozen in his pocket. Hell, I'm just a kid in the service."

A CPO who has a perfect conduct record is entitled to gold hash marks; otherwise they are red on the blue uniform, and blue on the white uniform.

There are two versions of how CPO's get gold marks. One is that they never did anything wrong. The other opinion, vehemently expressed, is, "They did a lot, but never got caught." "Undetected crime," the CPO's call it.

It is under the watchful eye of the CPO, with his long history of Navy service and work, that the new students learn to become submarine sailors.

At the base, the boats which are used as training submarines are drawn up and ready to go out. They are equipped with all the modern devices of operating submarines in active service, and the student doesn't miss a trick on them. With their white hats bobbing against the deep blue of their pea jackets, the student sailors walk out to meet their submarine.

The regular crew is already on board, getting ready for the practice run. On this first trip the students will merely travel as observers. Later, under the eyes of the regular crew, they will take over the controls.

The regular crew members look over the newcomers with a knowing eye. They have seen new sections come and go, and they can size them up in a short time. The new



The Chief Petty Officer explains the working of the periscopes to the men. At right is an anti-aircraft machine gun, wrapped in canvas.

bunch looks alert, doesn't horse around, and seems intent on learning.

Coming alongside, the student gives the pig boat the once over. The way it looks reminds him of the way the Confederates greeted the appearance of the *Monitor* during the Civil War, calling it a "cheesebox on a raft."

Long, lean and narrow, with the curved conning tower jutting into the air, the boat rocks gently in the water as the students stand and look her over. The CPO in charge of the section, a salty veteran of undersea boats, keeps up a running fire of information about the vessel which will be elaborated on later.

"All you can see from here is about one-tenth of the hull," he tells the group. "The boat floats in the water like a cake of ice, with most of it under the surface. The hull is shaped like a cigar."

The Chief indicates the pointed bow of the boat and the deck. "The deck and superstructure are built on the hull. That's what gives it a shiplike appearance. The main purpose of the deck is to make it convenient to get around, and it also provides a platform for the gun crew. If it wasn't for the deck, you fellows would look like a bunch of ants trying to walk on a slippery egg when you had to get around on the outside."

The Chief points to round openings in the deck. "You fellows have been around long enough to know what hatches are," he says. "The forward one leads into the torpedo room, there's one in the conning tower, and one into the engine room." The hatches are covered by doors or hatch covers, which are round metal discs, resembling sewer covers.

While the Chief waits for questions, the students look over the rest of the submarine exterior. They know the conning tower, which is built up in the center of the ship, but one of them isn't sure of what he sees at the bow and stern of the hull.

"Hey, Chief," he asks, unabashed, "what are those fins for?"

The Chief leads his group to the bow of the boat, where they can get a good look. "Those metal fins are diving planes," he explains. "They are in the bow and the stern. Right now they're folded, but when the boat is under way, they are used in steering the ship in an upward or downward direction, operating at an angle of twenty-five degrees in either direction."

Leading his section to the stern of the sub, the Chief continues, "Back here we have the tail assembly. That consists of the stern planes, which steer the stern of the boat in an upward or downward direction, and the vertical rudder, which steers the sub like any surface ship.

"By using both the stern and bow planes together, the vessel can be made to submerge or surface on a horizontal plane, or at any angle. The planes are operated from the control room. The rudder can be operated from the control room, the bridge or the conning tower."

"What kind of propellers does she have?" another student asks.

"Three-bladed. Usually they're made of bronze, and look something like the blades of an electric fan. When we're on the surface, they're driven by the Diesel engines. Below, they're powered by the electric motors."

By this time, the student has a clear idea of how the

submarine controls operate the boat, even though he hasn't been out. His fingers itch for a chance to get at the control wheels, and he's impatient to get under way.

The Chief then leads his charges across the gangplank, and the student sets foot on the deck of a submarine for the first time, his heart beating a little faster as he feels himself becoming a part of a new experience and type of life.

Following the Chief's lead, the group climbs up the conning-tower ladder, swarming over it like a flock of blue-jacketed monkeys. From this height the deck of the vessel seems longer and narrower than ever, and the conning tower seems to make it topheavy—until the student remembers that most of the boat is under the water. From above, he can see the rounded hull swell out as it curves down into the depths. On the conning tower, the Chief explains the various parts, showing the mountings for machine guns, the small hatch that leads down into the control room, and the navigation station. The navigation station contains all the instruments for surface navigation and control, all housed and watertight. When the submarine submerges, only the conning-tower hatch is closed, and the bridge is open. When the vessel rises, water drains out of the sides of the conning tower, leaving it dry by the time the officers and men are ready to use the station.

One student, with many questions in his mind, works his way over beside the Chief. "How big do these pigs run?" he asks casually, trying to sound like a veteran.

"Anywhere from a few hundred tons to several thousand," answers the Chief, leaning on his elbows. "In length, from two to four hundred feet, usually. You see the submarine's tonnage is figured two ways, surfaced and submerged. A boat that displaces seven hundred tons of



Down the hatch! A sailor comes aboard the submarine and
climbs down the conning tower hatch, ready to take his
station.

water when surfaced, would have a submerged displacement of eight hundred and fifty tons."

Some of the other students gather around to listen in, and the Chief continues. "All submarines, no matter what their size, have a similar general construction. Something like *Joc* and *Skeezix* over there. One's long and lean, and the other's short and fatter, but they're alike inside, although the outside might be a little different. All pig boats are equipped with internal combustion engines and electric motors, storage batteries, water ballast and trimming tanks, pumps, air compressors, air storage tanks, torpedo tubes and storage, crew quarters, and auxiliary equipment."

The students nod knowingly, and the Chief turns his attention to the final exterior description before taking the section inside. "These are the periscopes. We carry two. Some boats carry as many as four. When we get below, you can look through them. They work on the principle of reflecting mirrors, only these are carefully ground and adjusted to reduce distortions.

"When we dive, we usually go down to periscope depth. That's the depth at which a raised periscope is out of the water far enough that it is clear. The depth varies with different types of boats. On this type, it's forty-five feet. The periscope is raised about twelve feet, and it can be swung around in a complete circle."

The students look at the periscopes, the "eyes" of the submarine, which are a few inches in diameter.

"How far can you see with one of these?" one of the students asks.

"About two and a half miles when the submarine is submerged. On the surface; the range is increased to about six and a half miles."



A sailor takes his first look through the periscope. Although the periscope is manned by officers, the policy in training sailors is to have them know something about every operation on the boat.

"On the surface?" a dubious student asks, afraid he's letting himself in for a joke. "Why would you need a periscope on the surface? Couldn't you climb out and see for yourself?"

"You ought to know the answer to that," the Chief replies. "Don't you know the higher you are the further you can see? When we're on the surface, and the periscope is lifted, it's about twenty feet high. The boat itself lies so low in the water, that it can't be seen from that distance—but it can see.

"Sometimes," the Chief goes on, "ships try to fog up the periscope by spreading oil on the water."

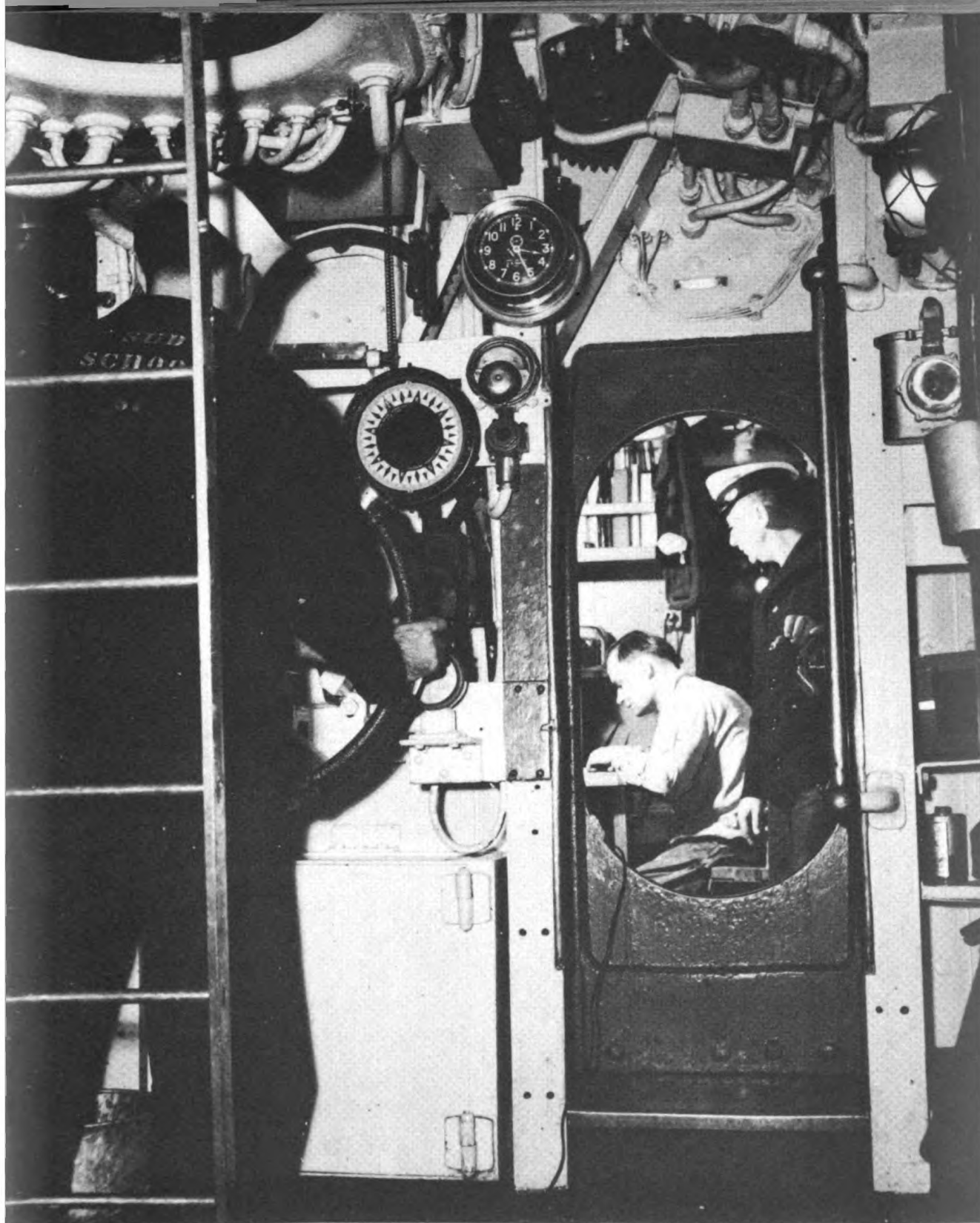
"Does it work?"

The Chief grins. "When you're that close, it's usually too late to try anything but heading for the life rafts. When the ocean seems deserted, the sub might come to the surface to look around. Any ships that are in the vicinity will usually be spotted by the smoke from their stacks. Then it's just a matter of trailing them down."

The student thinks this over. "Say," he asks suddenly, "how much truth is there about submarines lying off lighted cities to catch the silhouettes of passing ships? Is that straight stuff?"

"It's the truth," the Chief answers grimly. "Anytime you're where there's a glow, and somebody passes between you and the light, he sticks out like a fly in a bowl of milk. Then too, you're on the dark side, and he can't see you. You can practically tie a torpedo to his tail without being seen." The Chief looks at his watch. "We're shoving off soon," he says. "Let's get below. Go down the torpedo-room hatch."

The student climbs down the ladder and his feet hit the



The helmsman keeps the boat on its course while the navigation officer in the control room works out their position and destination.

deck once more. With his mates, he walks forward to the torpedo-room hatch, and when his turn comes, he lowers himself down that round hole in the deck, his feet feeling for the rungs of the ladders.

He goes down slowly, and in a moment his eyes are on a level with the deck. For a second he halts to take a last look at land, and then he goes down another rung, and he is inside the submarine.

His first feeling is one of being cramped. The group almost fills the torpedo room, and instead of the bright sunlight outside, there is only a ray of light coming through the hatch. The main lighting is given by electric light bulbs that glow in the compartment.

The student looks around slowly and feels a sudden impulse to run to the hatch and look at the sky again. Something inside him rebels at being cooped up. Some ancient inner urge makes him want to break out of this trap below the water. But he shows no outward sign of his uneasy feelings as he looks around. It will take a little while before he begins to feel at home in the restricted quarters of a submarine.

Before long he will lose the feeling that he is being penned in, and he will adjust himself to the conditions peculiar to undersea boats. No one expects it to come at once, and only practice and experience will bring full confidence and ease of mind. Meanwhile, he becomes acquainted with the layout of the torpedo room.

At the forward end of the room are the torpedo tubes, surrounded by wheels, levers and dials, and with huge spare torpedoes stored at the sides. Like the other compartments he will soon see, the torpedo room is equipped with numerous other valves and gauges that have to be manned when



In the forward torpedo room, "business end" of the submarine, a Chief Petty Officer shows embryo "torps" the first tricks of their trade.

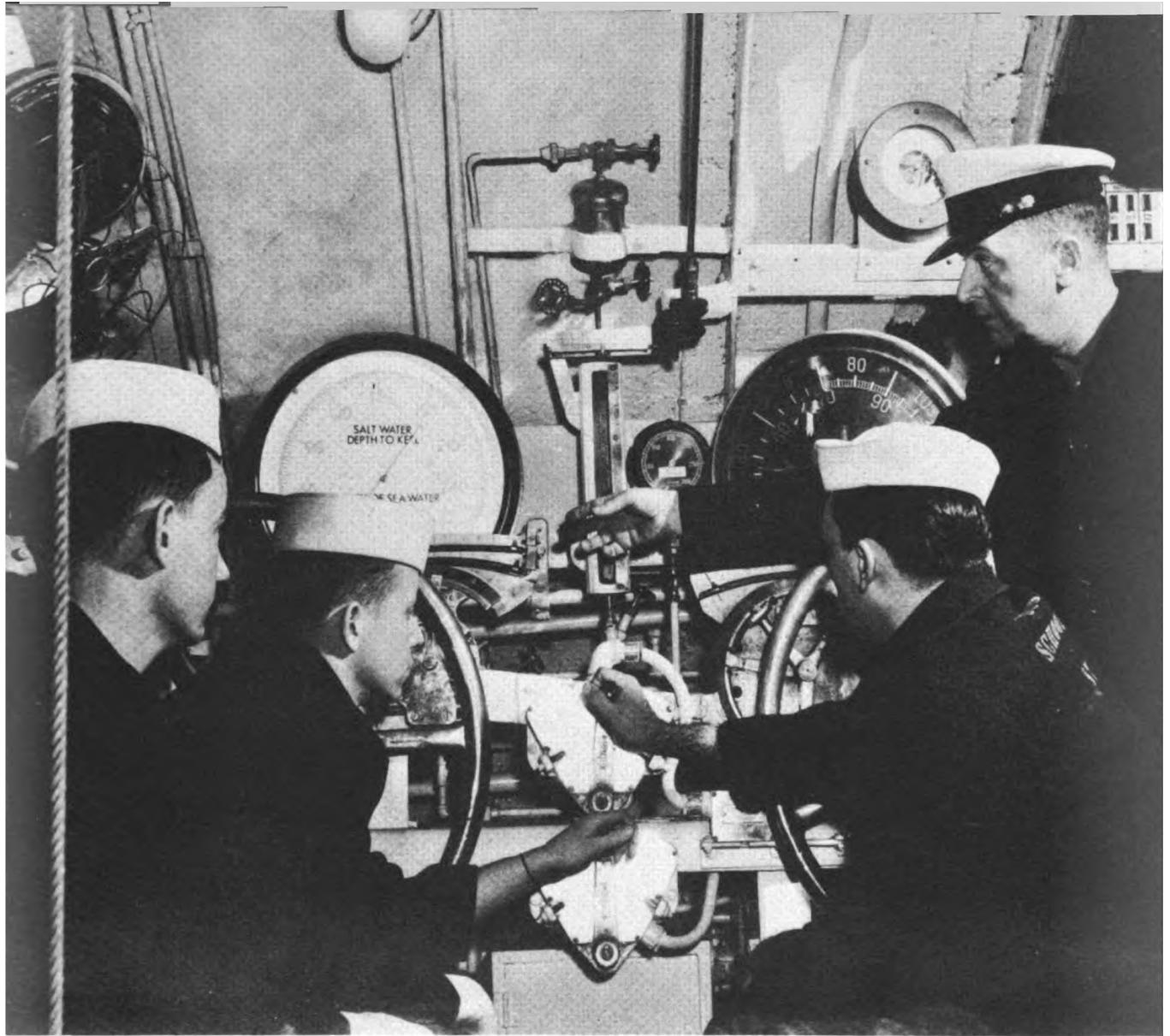
the ship is diving or surfacing. This first look staggers the student, and he feels that it will take him years to figure out how everything works. The old hands know that he will feel at home there in a few days.

The CPO in charge explains some of the equipment briefly, as a starter. Holding up an earphone, he shows it to the students and tells them, "When the order is given to man the battlephones, these go on your head. Let me illustrate how important internal communications can be: Suppose our sub is attacking, and the skipper gives the order to fire a torpedo. When the order to 'Fire one' is given, it must be repeated by the man at the battlephones. When that order is given, the chief electrician's mate presses a button to fire the torpedo electrically. If the torpedo isn't fired, because of some defect, it must be fired manually at once. Any delay would mean that the target would have time to sail out of range. That holds true for a lot of other things on this vessel. Orders have to be understood and carried out correctly the first time."

The brief preliminary survey of the torpedo room over, the CPO takes the students aft, to show them through the other compartments.

Just back, or aft, of the torpedo room, is the forward battery room. In here, as well as in every other compartment except the control room and the motor room, there are bunks for the crew. The bunks, when not in use, are swung up against the ship. Some are built in, resembling the baggage rack on a big motor bus.

Aft of the forward battery room is the control room, where the periscopes are, as well as the other equipment for navigation and communication, necessary to the operation of the ship. It is here the commander of the submarine



Learning how to “drive” the submarine, students are shown the hows and whys of the plane controls. There are planes on both the bow and stern end of the boat, and there must be close coordination between the men who are at the controls of each.

practically lives twenty-four hours a day, as he commands his ship.

Going back, there is the after battery room, the engine room, and finally the motor room, where the electric motors are.

In many respects, the submarine is a cosy, six-room apartment. It has to be, what with half a hundred men or more living there. Engines, motors and equipment take up so much space that every remaining inch has to be used for at least one necessary purpose, and sometimes more.

The modern submarine is not cramped, and there is room to move around freely. But there isn't any place to accommodate a tennis enthusiast or a confirmed hiker.

Every undersea boat carries a cook, or more than one, and he is one of the most important men in the crew. When the weather is bad, the enemy near, the acey-deucey (backgammon) board lost and a chess piece missing, the food had better be good.

And the food is surprisingly good, considering the conditions under which the boat must work and fight. Living below the surface doesn't affect the sailor's appetite, and when chow time comes around, he's ready to dig in with both hands.

To satisfy fifty or sixty vigorous eaters, the cook is equipped with a big electric stove that can do everything but think up new recipes. He boils, bakes, stews, fries and roasts, turning out pies that would give mother a good run for her money, and setting out sizzling steaks that nestle between giant green peas on one side and French fries on the other.

When meals are served, the men sit at a long, narrow table, with the upper bunks folded back on each side of



Martin Sheridan

The cook samples his own work. The galley is a marvel of compactness and efficiency, enabling the cook to prepare food for fifty men in a working space not much larger than a small kitchenette.

the boat in order to give them room. Nobody is sleeping at this time anyway, and the table is jammed with hungry men who make the food disappear as fast as it can be loaded on.

In its storage space, the submarine carries a supply of frozen meats, including steaks, turkey and other such delights. Fruit, vegetables and all the food items needed to create a balanced diet are brought along. At the end of a long trip the crew will be dehydrated, and thinner and paler, because of living under the sea, but they will not be underfed.

When the sailor sits down to breakfast with a large mug of steaming Navy coffee to warm his innards, he also finds that his morning cereal is before him, as well as fruit juice, perhaps a plateful of bacon and eggs, and some fresh fruit.

The sailor knows that he is getting the best the vessel can carry, and he digs in with relish. Afterward, a satisfying smoke sets him up for the day, and he is ready to lick the hull out of any enemy ship that comes into view.

It is not difficult to imagine the scene about dinnertime. The men who have gone off watch are resting in their bunks. Although they work only four hours at a stretch, the strain of those hours is enough to make a long rest welcome. And if the vessel is operating in enemy waters, there may have been hours when the entire crew was on the alert and at their stations.

The sailor, stretched out in his bunk, his eyes closed, listening to the muted sounds of the men at work, suddenly sniffs. His keen nostrils have picked up the scent of something cooking. His eyes are open as fast as the lids can move, and he pokes his head over the side of his bunk to talk to the man below him.

"Do you smell what I smell?" he asks unbelievably.

His buddy below pushes away the book he has been reading. "If I remember my youth," he says wistfully, "it smells like fried chicken."

"Fried chicken?" Three other bunks suddenly come to life as eager sailors peer forth, grinning. "Somebody off his nut around here, dreaming about fried chicken?"

One sailor swings off his bunk and decides to follow up the miracle. He slides up to the cook and is driven off with an upraised skillet by that indignant keeper of the victuals. "Shove off," he growls. "I'll call you pigs when the swill is ready."

The delighted sailor pads back to his bunk to confirm the good news. Fried chicken it is. Nobody has had much of a chance to remember that it was Sunday dinner coming up, and they thought the cook was "batting the breeze" for promising them a treat after they got that last Jap ship. But Sunday dinner it is, and the sailors get ready for it.

Bunks are quickly swung out of the way as the table is set, and the sailors douse the sleep out of their eyes with cold water. They're ready before the chicken is, and before long only the bones are left. There isn't much conversation while the food is on hand; but afterward those off watch limber up their imaginations, and the satisfied men talk about this and that ship they have attacked, and the scraps they have been through.

"Say, Bert," a machinist drawls, "what were you doing down on your knees when that destroyer was dropping ashcans?"

"Fixing that blankety-blank Diescl," the sailor defends himself.

Everyone hoots, and the boys ride Bert about saying his

evening prayers three hours early. Bert takes it, and parries every thrust, getting in some hilarious touches of his own.

Their spirits are high. Good food, good conditions and good equipment give the sailor confidence in every situation, and his greatest confidence is in his officers and mates. Their morale needs no artificial stimulant. The men love their work on the pig boats, and wouldn't trade jobs with anyone.

The lack of recreational facilities on the undersea boats throws the burden of entertainment on the men themselves. That may explain why the submarine men are good talkers, always ready with a score of funny stories. They learn how to entertain themselves, and this dependency on their mates for off-watch hours also tends to knit the crews closer together and to make them understand each other better.

But with a stomach full of dinner, and the grind of the electric motors for a lullaby, the sailor stretches out on his bunk and is asleep before he finishes laughing at the last joke.

Other creature comforts exist on submarines now that were never dreamed of by old pig-boat hands. It used to be that the men went for weeks without baths, disdaining to wash in salt water. They froze in the winter and simmered in the summer. At the end of a long trip they were like men who had been marooned in a jungle.

But today's sleek pig boat boasts shower baths, with running hot and cold fresh water to refresh the crew. The subs are also air-conditioned, eliminating foul and stale air and insuring a comfortable temperature. Aside from the question of comfort, fresh air is vital, because stale foul air affects the crew physically, lowering their ability. More-

over, some submarines carry automatic washing machines, and that means a constant supply of clean fresh laundry. All the comforts of home here, and some comforts not found in many homes.

All this does not make submarine work any less exciting. Dirt and danger are not necessarily the boon companions on a sub that they are in land fighting. The conditions found on good American submarines are not universal to all similar boats of all nations. The living and cleanliness standards of Americans have long been more advanced than those of any other nation, and they are kept up, whether there is peace or war.

A German refugee, Hugo Bleiberg, who was taken as a hostage on a French submarine, noticed a large number of rats on the ship. When he asked an officer why the rats weren't killed, the officer explained that rats weren't killed because it would be bad luck for the ship, which would surely be sunk.

Although such superstitions are few and far between in the American submarine service, especially as regards rats, Jerry the Rat is one rodent who is famous wherever Yankee submarines go down into the sea.

Jerry was supposed to have been a pet rat on an American sub. He was, according to the story, fat and well-fed, and given to kibitzing pinochle games by the men off watch. He also was greatly interested in drills, and seemed to understand what was going on. In his other leisure moments, Jerry read the latest magazines and newspapers available, being rather partial to girly pictures in the former, and to the financial section of the *New York Times* in the latter.

Eventually the submarine received a new commander,

who cared not a whit for the rat, and ordered his speedy dispatch. The crew, obediently carrying out orders, set out after Jerry, with violent intentions. But Jerry, who had been in the submarines for a long time, knew what was coming, and went down into the bilge, where he was safe from human molestation.

The crew then decided to get him with gas. Securing the compartment, they set off some cyanide fumes, and watched through the ports to see what Jerry would do.

And what Jerry did, according to a number of solemn CPO's, was to "crawl up the auxiliary tank gauge out of the bilge. He ran to a chest, broke out a gas mask and adjusted it over his head, the way he'd seen us do it in drills. Then he looked up at us, put a thumb to his nose and gave us the Shanghai gesture. So what the hell, we made him a service record, gave him a gold hash mark, and shipped him over."

So much for the living arrangements and rodent yarns. It might be worth mentioning here that the cook, in addition to cooking, also has other stations to attend to. He has a diving as well as a battle station, and his knowledge of the submarine must be as good as any man's.

As stated previously, each submarine has both ballast and trimming tanks. While the boat is on the surface, the main ballast tanks are dry. These tanks, which are built into the lower part of the vessel, extend almost the length of the submarine. Into them, water is flooded from the sea through the ^{Hydraulic Manifold} kingston valves. When the tanks are flooded, the submarine submerges. The ballast tanks can also be blown dry with compressed air through the same kingston valves, and when that happens, the submarine comes to the surface.

In case the vessel has to go down quickly, the tanks are flooded, the planes are inclined for a dive, both propellers driven full ahead, and the submarine goes down at an angle, driving nose first into the sea.

If the commander wants to remain on the surface, but in readiness for a quick dive, he "rides the vents." In the top of the ballast tanks are installed vent valves. When the ballast tanks are flooded, the vent valves are closed, forming an air pocket in the top of the ballast tanks. In this condition the boat will remain afloat, although riding lower in the water. When the vents are opened the air escapes, and the boat submerges quickly.

The trimming tanks are located in the middle and fore and aft of the boat. Their purpose is to preserve the proper balance and angle at which it submerges. If the submarine is too heavy at one end, water is pumped into the trimming tank at the other, to bring back an even balance. The middle tank is like a weight in the center of a seesaw, throwing extra weight on whichever side it is needed to keep at an even keel.

Before getting ready for a dive, the submarine must be compensated. Water must be admitted to, or expelled from, the tanks. In the case of a first dive, the ballast tanks are fully flooded, and the trimming tanks are slowly flooded until there is little positive buoyancy. When positive buoyancy remains, the ship must be driven under by her propellers and diving planes. By trimming the ship in this manner, the safety factor is greatly increased.

The question of negative and positive buoyancy is just another one of the many problems concerning the submarine in operation. If it has positive buoyancy, it will float on the surface. No matter how slight the positive

buoyancy may be, the submarine will float to the surface unless kept submerged by its motors keeping it in motion, so the planes can be used.

If there is negative buoyancy, on the other hand, it will sink to the bottom unless it keeps moving fast enough—just as an airplane has to keep a flying speed to keep aloft.

Weight and the knowledge of weight are of supreme importance on a submarine. Every change in weight and every shift must be known and compensated for. When a submarine is out for some time, a close check has to be kept on all weight data so that the trimming tanks can be used to compensate for any change.

Weights are always changing. For example: A crew of forty-five men eats 150 pounds of food each day. That weight must be compensated for. Water to equal the lost weight must be let in, and it must be let in as close as possible to the place where the weight was lost.

Assuming that ten days have passed between a previous dive and one being planned, 1500 pounds of food have been eaten, and that weight must be compensated for before the submarine can dive again. Where is the submarine lighter? Where must the water be let in?

To figure this out as it would be figured out by a submarine officer, we will assume that we are dealing with a boat two hundred feet long.

100	80	60	40	20	00	20	40	60	80	100
90	70	50	30	10	10	30	50	70	90	
AFTER										FORWARD
TRIM										TRIM
TANK										TANK

Here we have our weight curve. Zero is the center of the ship. The food was stored aft of the ship at twenty. Twenty is 20 per cent, or one fifth, of the distance from zero to one

hundred. One fifth of the 1500 pounds of food is 300 pounds. Three hundred pounds of salt water are taken into the auxiliary, or center tank at zero, and the ship is compensated.

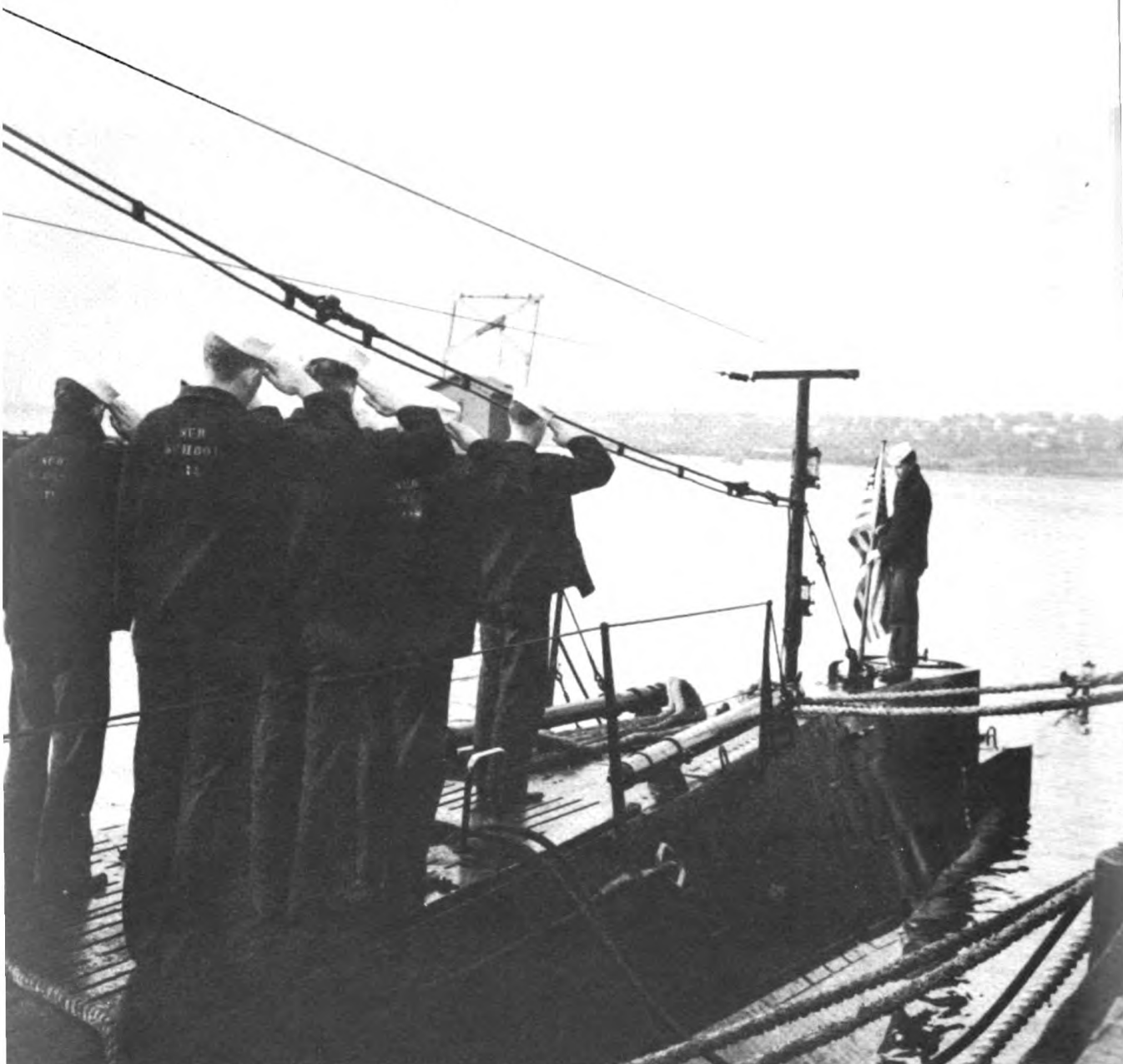
Suppose a torpedo has been fired. That weight also has to be compensated for. If the torpedo was removed from seventy forward, on the weight curve, the submarine will be compensated as follows:

The torpedo weighs 2700 pounds. Twenty-seven hundred times seventy hundredths (or seven tenths) equals 1,890 pounds. This amount of salt water will be flooded into the forward trim tank, and the remaining eight hundred or so pounds of water will flood into the auxiliary tank at zero.

Still the submarine is not compensated and ready for a dive. Since the last dive, the Diesel engines have used one thousand gallons of oil. The fuel tank, which is located at forty aft, must always be full when the submarine dives. If one gallon of oil is used, a gallon of sea water takes its place.

But here is a problem. One gallon of oil weighs seven pounds. One gallon of sea water weighs, roughly, eight and one-third pounds. Yet both take the same space. That means for every gallon of fuel oil used, the ship has become one and one-third pounds heavier from the sea water in the tanks.

Multiplying one and one-third pounds by one thousand, the number of gallons of water admitted, gives us 1333 pounds in the fuel tanks. As the tanks are at forty aft, this figure is multiplied by forty one-hundredths, which leaves 533 pounds. This amount is removed from the after trim tank. The remainder, or 800 pounds, is removed from the auxiliary tank at zero.



Student submariners salute the colors before getting under way in the morning on a training dive.

Of course, if the scientific method gets too involved, the problem of trimming the ship can be handled by an agile fat man, like the legendary Myers, who is said to have weighed 346 pounds.

With Myers on board, the hundreds of dials and gauges could be forgotten. The skipper only had to shout, "Myers, go forw'd; Myers, go aft. Hold it—a little more forw'd." And the ship was properly trimmed.

Myers was fat fore and aft, but narrow on the sides, which made him ideally constructed for slipping through the bulkheads. In maneuvers, Myers went thundering back and forth in the ship, following the skipper's barked orders, and in so doing piled up a record for having run more miles under water than any other human trimming tank.

As Myers was in the habit of getting stuck in the bulkhead doors once in a while, he wasn't too dependable, so it was decided to use regular trimming tanks instead of equipping every submarine with his equivalent. Besides, when he got stuck, it took all the butter and grease on board to get him out, and the sailors had to eat their bread dry.

Coming back to the submarine preparing for a dive, and considering it compensated, the crew is ready to take her down.

Now the training boat is ready to start out on her morning run. Down below, moving swiftly and surely among the maze of instruments, dials and gauges, the regular crew jumps to its stations, while the students watch, and try to remember.

A student jumps as the Klaxon bawls stridently. A moment later the boat trembles as the electric motors are

started, and the sub casts off, swinging away from the pier.

A few feet out, the Diesels catch on with a mighty roar, while white smoke belches out of the side of the boat. As the engines throb, and the deck shakes beneath the feet of the student, he turns his head from one side to the other, trying to see everything at once.

In each compartment, the students who will later take over the stations watch the regular crew take the vessel out to sea. From the bridge outside, the commands are jangled to the engine room, and the engines are regulated accordingly. There is just enough room between the huge Diesels to allow passage, and the machinists are on the prow, watching their giant power plant as it buckles down to work.

"Is the boat hard to steer?" a student asks.

The Chief grins again, his leathery face creasing into a thousand tanned wrinkles. "Not ordinarily. There is power operation of the rudders usually. But when you're out on training, the skipper's gonna give you plenty of practice steering the old girl by hand. And it's a good man who can hang on to those wheels for much longer than five minutes."

The student nods, looking at the heavy control wheels. He flexes the muscles in his shoulders, as though anticipating the time he will be gripping that wheel and steering directly, without any power to help him move the fins as the boat goes through the water.

"Say, Chief," another sailor breaks in, "we're having an argument. I say a sub can only submerge on a horizontal plane, or nose first. This guy says it can go down by the stern. Who's right?"

The Chief pauses before answering. "You can take her



Officers and men catch a last breath of outside air before going below to prepare for the dive.

down by the stern," he says. "But it takes a damn good crew to do it. But it's not a necessary operation. It's just the way pig boats brag."

Still moving slowly, the submarine backs into the middle of the river and noses around, moving downstream toward the sea, her flag flying in the morning breeze while below it an officer stands atop the conning tower in the navigation station, directing an enlisted man who handles the controls.

Silently and majestically, the boat slips down the river toward the sea, where the horizon is lost in the distant haze. The choppy waves break over the lean bow as it moves out to the diving waters. Once there, she stops. The students come out of the hatches and stand on deck, looking around, feeling the minuteness of the narrow deck on which they stand.

Now the crew lowers the flag and takes it below. The radio mast also comes down, and the crew goes back into the submarine through the open hatches.

The commanding officer gives the word: "Rig for dive."

His order, as are all his orders, is repeated by the diving officer, and is carried to all compartments by intership communication.

When this order goes out, the following things take place on the submarine at the same time, in the various compartments: all hatches but the conning-tower hatch are secured. In the torpedo room, the torpedo tubes are flooded with water, the valves to the forward trim tank are opened and all valves checked.

In the forward battery compartment, all main ballast tank stop valves are opened. The battery ventilation discharges into the compartment.

In the control room, the bow planes are rigged out, and the bow and stern planes tested. Two air tanks of 2500 pounds pressure are put into service. Both periscopes are tested, valves checked and pumps made ready.

The after battery compartment is rigged the same as the forward battery compartment.

The engine room does nothing until the diving alarm sounds.

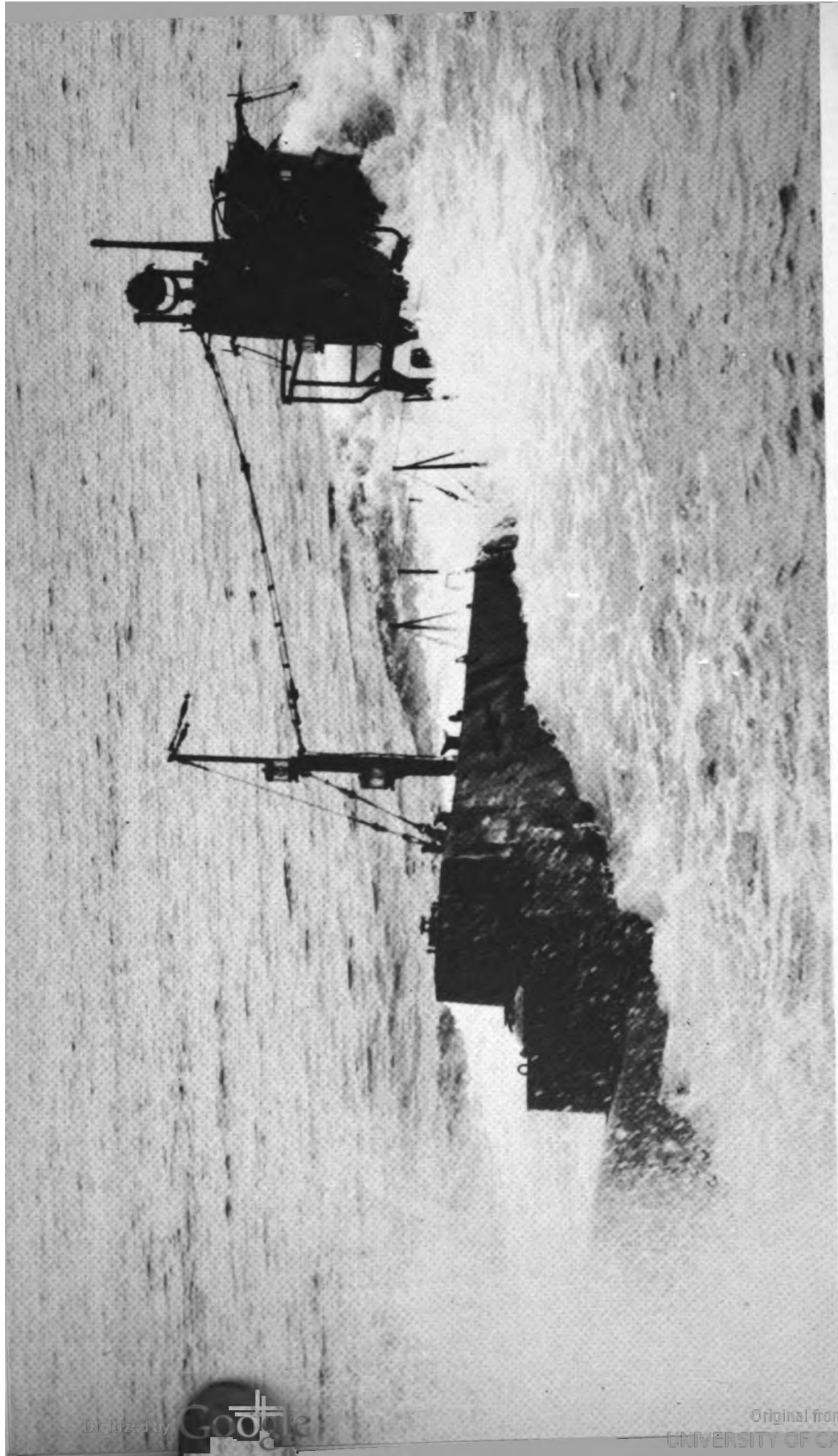
In the motor room, valves to the after trimming tank are opened, enabling the tanks to be flooded or pumped from the control room. When the ship is reported "rigged for diving," it is inspected by the diving officer, chief of the boat, or both.

The students notice that there is a changed atmosphere on the boat. All the men are intent on their work, and seem to have forgotten the student observers. There is a certain tightening about the way the men act. Everything is being done crisply.

The students gather a little closer together, waiting to see what happens when the ship dives. Suddenly the first diving alarm wails, making them jump. Hardly has the sound died down, when the crew members work furiously at the kingston valves, and the sea water starts pouring into the ballast tanks.

As the water pours in, it expels the air through the in-board vents with a deafening roar that makes it seem as if the sub is sinking—a sensation that the students, with their surface ship training, do not find comforting.

As the boat settles lower into the water, the regular crew secures the Diesels, and the propellers are changed over to the electric motors. The bow and stern planes are rigged out, and the men who are to handle them are in front of



Ballast tanks full, planes on hard dive, and electric motors surging with power, the submarine points her nose at the bottom and dives down beneath the surface.

their big wheels. At the same time, the conning-tower hatch, the last opening, is closed, and the men are ready to go down in their sealed steel vessel, as the water begins to splash around the base of the conning tower.

Below, everything is quiet. The men stand at their valves and wheels, eyes and minds intent on their jobs. The only voices heard are those of the commanding officer and the diving officer. In the control room the "christmas tree"—the panel of red and green lights showing the condition of the valves—is brightly lighted.

Suddenly the second diving alarm rips away at the silence. The main ventilation valve is closed, the ballast tank vents are opened and the tank floods completely. The usual thing on a dive is to take the ship down to periscope depth. That is the depth at which the periscope, when fully up, is out of the water enough to give a view of the horizon.

In a few seconds the submarine is forty or fifty feet under the water, depending on what its periscope depth is.

When cruising under the surface, the low whine of the electric motors makes a steady, unbroken sound. The ship moves along at from one to ten knots, keeping an even keel. The students, their nervousness gone, watch the regular crew go about duties that will soon be theirs.

With an even speed, the men at the wheels controlling the planes and rudder have the main task of steering the submarine. The others look after their motors, and keep an eye on their dials and gauges.

In a little while the captain decides to surface. He looks around through the periscope and sees that everything is clear. He gives the order to his diving officer: "Surface."

The diving officer in turn orders, "Plane up."

The planes are set on rise, and the ship is driven to the



Enemy sighted! A keen-eyed officer gets a quick look at the target, while the torpedomen stand ready to send their "fish" bubbling through the water.

surface by the propellers. At the order to surface, the man at the high pressure manifold lets air into the ballast tanks, which blows out the water through the kingston valves.

Lightened, and driven by her motors, the submarine breaks the surface, splitting the choppy waters as she comes up from the deep, shaking off water like a dog. As soon as the ballast tanks are dry the kingston valves are closed, and the ship is riding on the surface in her normal surface trim.

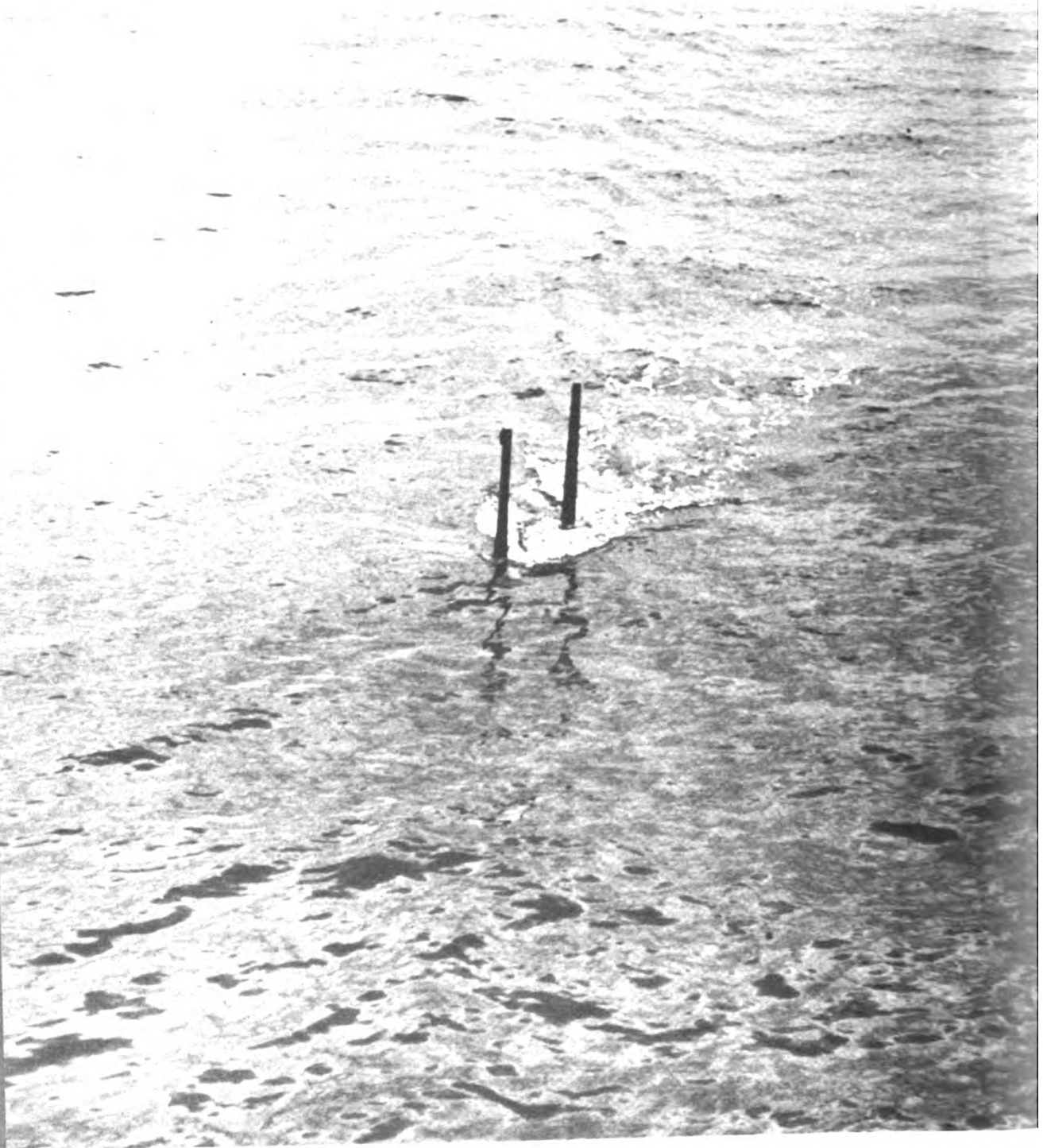
On orders, "Secure from dive," the electric motors are secured, and the Diesel engines are coupled to the propeller. The engines are started, and the submarine heads back toward the Submarine Base, her morning dive over.

From this time on, until his period of practical submarine work is finished, the student goes out time after time. But he is no longer an observer. He takes his station and performs his duties under the watchful eyes of the crew.

In a short time he is familiar with the "feel" of the submarine, and becomes adept at his task. Every man on the submarine has at least two jobs. All of them have diving stations plus their regular duties.

In action, all hands are at battle stations. The diving section which is on watch takes care of handling the submarine. The others take care of the fighting. Each section works four hours, then has eight hours off. During normal times, the time off is spent sleeping or in whatever type of recreation appeals to the sailor. But during a battle there is no sleeping or loafing, even if one were so inclined.

In the torpedo room the torpedomen trundle the big fish to the tubes, and stand ready to fire at the signal. A certain group of men will be detailed to the deck gun, in case it should come into the action, and others to handle the machine guns.



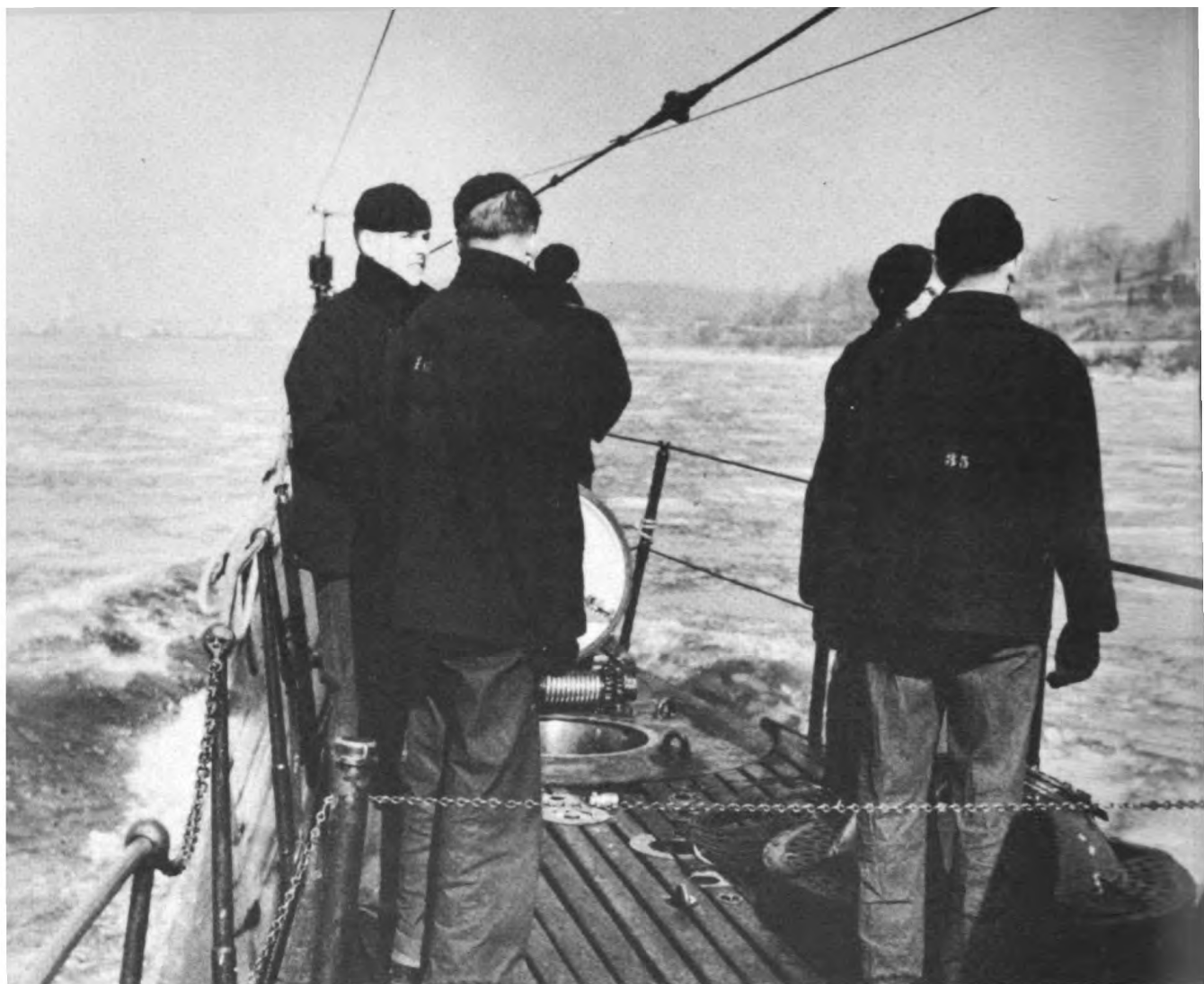
Cruising along at periscope depth, which is about forty-five feet with this submarine. In action, periscopes are only exposed for a few seconds at a time—just long enough for the commander of the boat to get the position of the enemy.

On each practice dive, each student gets a chance to work at his specialty. Machinists hover over their motors and engines like mother hens, keeping them running sweetly. The men in the torpedo room and the battery rooms stand by their valves and levers, ready to take in or blow out water, as the situation may demand. In the control room the others stand at the planes and rudder, carrying out the steering orders of their commanding officer. All in all, the diving section is at work, learning how to handle their pig boat.

In the course of training, students take their training ship through all the motions of actual battle conditions. Crash dives are rehearsed, gas drills are carried on, with the men going about their jobs in masks, and escape technique is practiced.

Day after day the submarines go out, carrying their student crews, until each diving section really becomes the team that the instructors are trying for. The dozen or so men who go out together learn how to work together as a confident, smoothly functioning unit. By the time they have finished their practice period, they are able to handle a boat like veterans.

They learn how to live and be comfortable in restricted quarters, until they feel uncomfortable on land because there is so much waste space to clutter up the country. But it isn't long before the diving section gives up its trips to sea to spend all its time in classrooms and laboratories. By the time they are ready to go to sea again, it will be as competent undersca sailors, ready to take over on one of the many new submarines being turned out by Uncle Sam to meet the Axis undersea fleet torpedo for torpedo, and gun for gun.



Martin Sheridan

Going home, the training submarine plows up the Thames River to the Submarine Base at New London, Conn. The morning period of training dives is over, and the sailors are anxious to get on to the next bit of activity—lunch.

The dive is over, and the "O" boat is heading back to the base at New London. It has ten or twenty miles to travel on the surface before it gets home. The members of the crew who are on duty stand before their wheels and gauges. An officer is in the conning-tower bridge, where the boat is being controlled as it returns.

Now that the dive is over, the crew members who are off watch gather around with the students, all drinking coffee and "batting the breeze."

Tradition is that no one sleeps on the last night before port, even though the vessel has been out for weeks. On any homeward trip, especially after a long one, the last few hours are given over to matching tall stories, and in seeing who can tell the biggest lie. Everyone knows they are lies, but tradition also has it that no doubts are voiced about even the wildest tale.

Students, of course, present the best audience, and everyone is eager to hear the Chiefs and the veterans spin their yarns about submarine life. Invariably, someone asks about rats on the boat, and Jerry the Rat becomes known to a new group of sailors.

Even here, with mugs of hot coffee going down, the serious education of the students is carried on. A student perched on the edge of a bunk calls to the Chief. "Who ever invented these pig boats? Seems to me I never heard about them until the Germans started using U-boats in the last war."

The Chief snorts in derision. "Germans? They're Johnny-come-latelys. Submarines are hundreds of years old."

The student looks doubtful, suspecting another joke.

"Yeah?" he says. "I suppose George Washington crossed the Delaware in a pig boat."

"He didn't, but he could have," the Chief answers. "Haven't you ever heard of Bushnell's *Turtle*?"

The students shake their heads. The Chief refills his coffee cup, gets comfortable, and prepares to give them a little submarine history. "You'll get all this in class, later on," he says, "but it won't hurt you to know something about it now.

"The first really successful sub was built and operated in 1622, by a Dutchman called Van Drebbel. He carried a crew of twelve, and passengers. One of the passengers was supposed to have been King James I of England."

"What did they use for power?" someone scoffs. "Electric motors?"

"Oars," says the Chief, casting a withering look at the scoffer. "Oars. Had them stuck out the side of the boat with flexible diaphragms to allow motion. They made a trip from London to Greenwich at a depth of fifteen feet."

"What about the *Turtle*? Tell 'em about the *Turtle*," a regular crew member urges.

"Well," the Chief goes on, "this *Turtle* was built by an American named Bushnell to use against the British during the American Revolution. It resembled an up-ended barrel in the water, being higher than it was long. It had a crew of one, and was powered by an oar projecting through the stern. Another oar in the top gave it the power of diving and rising. And believe it or not, it had valves to let in water ballast and pumps to force the water out.

"Well, Bushnell built the *Turtle*, and an army sergeant name Lee volunteered to try it out against the British. For a victim, they picked out the *Eagle*, which was a ship of



Martin Sheridan

Starting out for a training dive in the early morning, the sun is bright on the waters of the river. White smoke pours out of the side as the cold Diesels are warmed up, and a few of the crew, still a little sleepy, stay out in the brisk, cool air.

the line, carrying sixty-four guns. Even in those days the submarine didn't care about odds.

"The *Eagle* was moored up the Hudson, and one night Lee got in the *Turtle*, hooked on an explosive of one hundred and fifty pounds, and submerged, heading for the British ship.

"His idea was to dive under the ship and come up against her bottom, and attach the explosive. Then he was to light the fuse and get away.

"Lee got under the *Eagle* all right, but that's when his troubles began. He had to fight the tide, and he had trouble boring into the hull of the ship so he could attach his mine. Besides, he had only enough air for half an hour. He couldn't do everything at once, so he had to come up for air. The British saw him and opened fire, but he dived and got away. The mine floated away and exploded. They tried the *Turtle* another time, but she was sunk by the British, and that was the end of submarine warfare for a long time."

When the Chief finishes, he gets a round of admiring remarks from the students. They grin at each other as they enjoy the stories, already feeling like old hands.

"I never read about that in school," says a red-haired student.

"What's a teacher know about pig boats?" says another, deprecatingly. "Should have had the Chief here for your teacher."

The Chief warms up under the good reception his stories are getting. "Ever know Robert Fulton built a submarine?" he asks, looking from one to the other.

The students reply with a chorus of "Noes." The Chief shakes his head. "Where you all been brought up—in the

hills? You're plain ignorant. Don't seem to know anything." But he is glad to have the chance to tell them more. "Robert Fulton," the Chief says as the students crowd in a little closer, "built a submarine which he called a plunging boat. Called it the *Nautilus*. Napoleon had him build it. You fellows have heard of Napoleon, haven't you?"

"Don't tell us he rode on the *Nautilus*!"

"No, he didn't. But he saw her dive. On July 3, 1801, if I remember the date, Fulton took the *Nautilus* down in the harbor at Brest, France. Sailed out first, then struck his sails and dived. He went down to twenty-five feet, and stayed there an hour, in complete darkness. Next time he went down, he had ports put on the *Nautilus*, just like we've got them, and he got light from that. Not only that, he took along compressed air, in flasks, and stayed down several hours, cruising around while submerged."

"Did he ever use it in battle?"

"Tried to. Fulton also invented torpedoes and mines of one sort and another. They worked in practice, but something always went wrong in battle. He fought for the French against the British, and then for the British against the French. But he never sank any ships.

"Why, in the Civil War we used submarines of a type. They used to tie explosives on the end of a long pole and ram them against enemy ships. Spar torpedoes, they were called. It was tougher on the submersibles than it was on the other ships, but they did sink some, and showed that the idea of a submarine vessel was practical in warfare.

"But modern submarines were really invented by John Holland and Simon Lake, two Americans. The boats they built weren't much different from the one we're on right

now. You know some of the early subs used to be built with wheels, so they could ride on the bottom of the ocean."

"Tell them about the time you were on one of those subs with wheels," breaks in a member of the regular crew. "That's really interesting."

"We had one here," says the Chief, "and I was on her the first time she went out. The skipper took her down the river, and we submerged, and started rolling along the bottom on those big wheels, just as smooth as you please."

"We must have cruised around for about an hour, when the skipper decided to up the periscope and have a look around. He looked and, believe it or not, we were in the freight yards of the New Haven Railroad, going down the tracks like a bat out of hell." The Chief shakes his head. "An engineer on a train coming into the yards saw us, and the poor feller went nuts."

The Chief finishes his coffee and refills his cup. "If you think that's strange, let me tell you about the time I was stationed . . ."

Before the student knows it, they are chugging up the Thames River to the base.

Chapter Three

CLASSES—SCHOOL AND ROUTINE

AFTER THE PRESSURE tests, physical exams and preliminary submarine experience, the school routine begins, and is worked in with continued practical work until that course is completed. Then, for the rest of his stay at school, the student attends classes and works on shore equipment and in the laboratories.

Men who have volunteered are admitted to the Submarine School according to need. In assembling a crew, one or more men in the following categories are needed: Electrician's mate, machinist's mate, torpedoman, radio-man, signalman, cook, gunner's mate, yeoman, and seaman.

Like everyone else in the Navy or Army, the student gets up early in the morning. A typical day will follow this schedule:

6:15 A.M.	Reveille
6:30 A.M.	Breakfast
7:40 A.M.	Quarters—muster and 15 minutes of physical drill
8:00 A.M.	Classes until 11:30 A.M.
11:30 A.M.	Lunch
12:45 P.M.	Classes until 3:45 P.M.
4:00 P.M.	Clean up, recreation, or watch
5:30 P.M.	Supper. Free period until lights out, except for those with liberty
9:45 P.M.	Lights out. Those with liberty are free until 7:40 A.M.

When the student is routed out of bed in the morning, he has fifteen minutes to dress, wash, make his bed and race for his food. When he hears the call of "Show a leg, sailor," he knows he's got time to do everything if he's out of his bunk and on his way.

The much-used expression, "Show a leg," did not, originally, refer to the sailor's leg. According to students of the old navies, sailors were allowed to have their wives on board ship. In the morning, when the men were routed from their hammocks, the call, "Show a leg," meant that any sailor who had a wife with him might tell her to dangle one leg over the hammock. This proof of the presence of a wife enabled the sailor husband to remain in bed longer than those sailors who had only their own legs to exhibit.

Today, however, the expression refers only to the sailor. Submarine men who are married often have their wives and families living in the town where they are based; for those in the school, frequent all-night liberties enable the student sailor to be at home almost as much as any working husband.

Breakfast, like the other meals, is eaten in the large, cleanly scrubbed mess hall on the school grounds. Meals are served cafeteria style, with the hungry student passing down the line and loading his tray with the good Navy food that is provided in abundance. There are large tables at which to eat.

The diet at the school is carefully balanced and well prepared. For breakfast, the hungry students get their fill of fruit or fruit juices, cereals, cream, eggs and just about anything else that is ever served on American tables.

Other meals are also a delight to a young man's heart—and stomach. The Navy cooks aren't "bean specialists"



Here's one thing submarines and infantrymen have in
common.

Martin Sheridan

these days, and their cherry-pie desserts, full-bodied soups and golden brown roasts win the hearty approval of good appetite from the student who considers himself an authority on food.

The rattle of dishes, the collisions between knives and forks and the requests for more food are the regular sounds of this part of the school routine—and they're real, not practice, attacks that are being made on the provisions.

After breakfast the student is mustered, reports for duty and starts the next part of the day with fifteen minutes of what the British call "physical jerks," but which we, with our vocabulary of, and sensitiveness to, slang, prefer to call calisthenics. This is done under the direction of "one of the Tunney men," who stands on a platform and faces the men. Arm and knee bends, scientific twistings and jumpings are carried out until it is time to report to class.

From eight until four, classes and practical work take up the student's time. He may, for instance, spend the morning on a submarine and the afternoon in a classroom, or vice versa, depending on the schedule for his diving group. His day may be divided between lectures and lab work, or whatever happens to be ahead. One thing is certain and can be told—he works and studies hard.

At four, everything is cleaned up. Some of the students will rate liberty until next morning, and most of these will go to town as soon as they can, returning any time until muster the next morning, when they must be ready to work or study for the day.

The remainder of the students will be limited to the school, with some of them standing watch, which means they have duties and work to perform until supper.

Watches are assigned in a manner that gives everyone an equal share of work.

For those who stay at the school, and are free for recreation in the afternoon, and for all those whose time is free in the evening, there are excellent facilities.

Besides the opportunities that exist for outside sports—and swimming is one of the most popular—the recreation hall would be a credit to any first-class resort or school.

In the main large room, there are a number of modern leather and metal chairs, comfortable and inviting. The ping-pong tables are usually busy with the actively inclined sailors showing top form with the paddle. At the billiard and pool tables, sharpshooters are torpedoing the eight-ball while others stand around and give advice on the cue gunnery.

For those sailors who want to relax physically, but wish mental stimulation, there are places for checkers, chess and other table games—plus chairs for kibitzers. Weekly dances are held in the recreation hall, and are very well attended. Some of the sailors have danced in practically every continent on the face of the earth, and their dancing has an international flavor and smoothness which is dusted off to the music of live bands or canned music, as the case may be.

In the basement, there is a modern bowling alley, with four alleys for those who go in for this particular type of recreational bombardment. A shooting gallery is off in another room, and it is the favorite noon haunt of young officers, shooting a .22 pistol on a .45 frame.

Near by are the school theater and auditorium. The stage is rigged up with a ring when there are local boxing or wrestling tournaments, but this is taken down when the

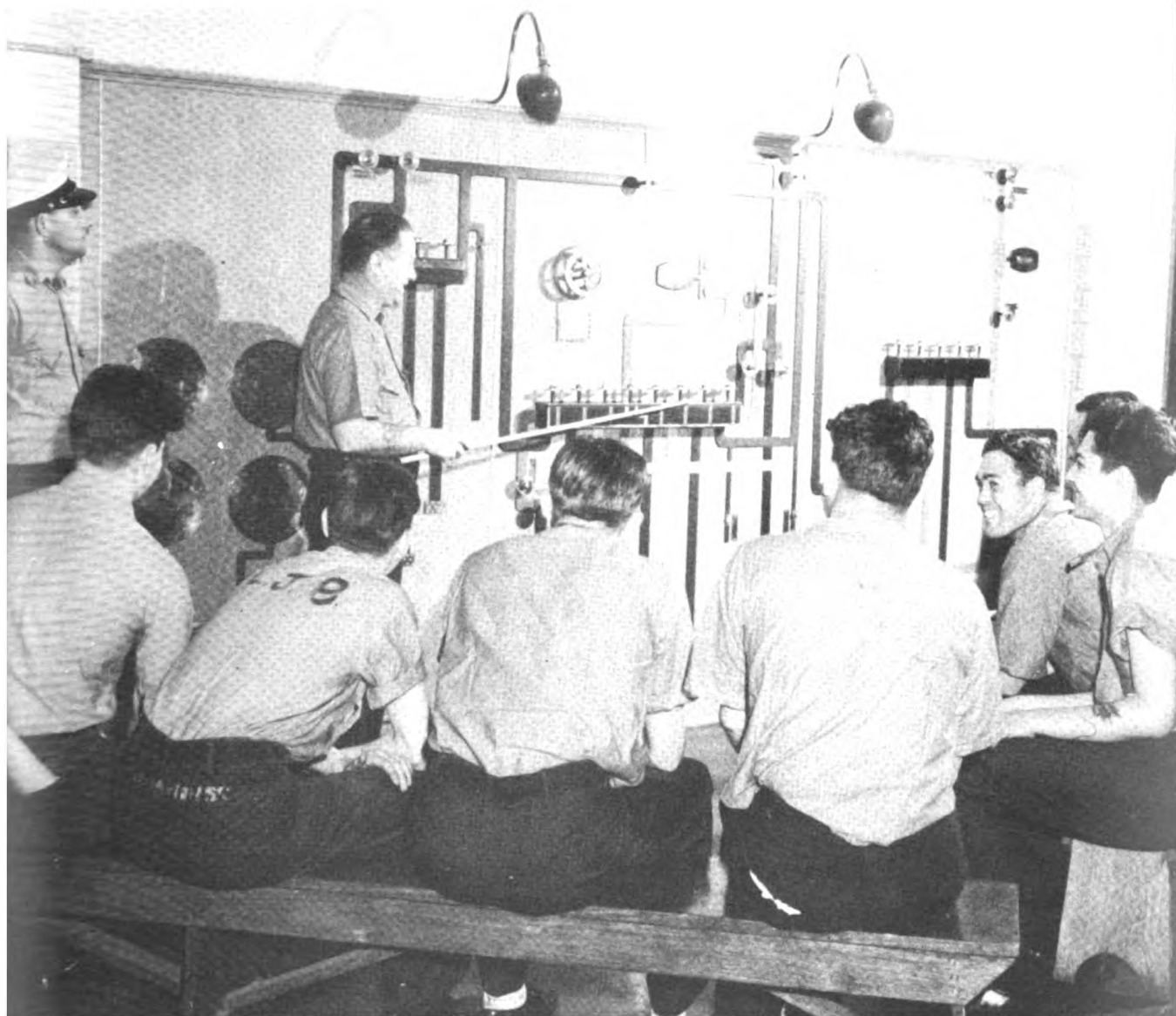
stage is occupied by visiting name bands or stars of stage, screen and radio. The theater is equipped with a fine screen and projector, and the movies which are shown, costing the men and their guests five cents each for admission, are new films which are being shown at the leading houses in the country.

In this way, the student leads a well-balanced life, mixing in plenty of play with his work and study. Much of the reason for the healthful appearance of the sailors around the school is the kind of life they lead, with plenty of good food, rest, recreation and stimulating, interesting work.

The mental health of the submarine student is not neglected either. Although many students come through the school, each one receives close individual attention in his work and development. In order to be in the Navy in the first place, and to be accepted by the Submarine School in the second, the student has already had to show a certain excellence in work and character. Sometimes, however, there may be a defect in the student which would not affect his work on large surface ships, but which is serious in connection with undersea duty.

Some of the things which will be considered, for instance, are the habits and temperament of the student. Does he drink? If so, how much? Is he a nervous type? If the answer is a decided affirmative in such cases, the student may even be dropped from the school.

The reason for this is apparent. Drinking, if heavily indulged in, can't fail to affect the physical fitness of the student. In addition, it is a sign of nervousness and tension. Under the rigid and sometimes trying conditions of submarine warfare, calling for steady nerves, calmness and endurance, the man who is used to drinking to stiffen himself



Electricity is the lifeblood of submarine operation, and here electrician's mates learn the construction of the main control panel.

may prove unable to function efficiently when he is most needed.

On a submarine, each man has a definite responsibility, and if he is lax in his duties, he may affect the fate of the entire ship. Therefore, a student whose past record shows instances of irresponsibility, has that record to disprove if he wants to continue school and be assigned to a submarine. If a student is known to break even small or minor promises easily, it is taken as an indication as to his general attitude and trustworthiness.

Alertness, quickness and ability in carrying out orders, manual dexterity and adaptability are all considered. Anyone with a tendency to get his thumbs in the way of his fingers when working isn't cut out to be a submarine sailor, even if his brain works fast. The coordination between mind and muscle has to be quick and efficient when a few moments may mean the difference between victory and defeat.

A submarine man should have a lot of drive, should have good judgment and be emotionally stable. These are qualities of the average healthy American boy, and not many men are ever dropped from the school because they lack them. And not everyone who shows tendencies for certain weaknesses is dropped. Many such tendencies can be corrected, with the result that the individual is a better sailor and a better man.

Personality also counts. The men are working and living in small quarters, often under strain, and always together. There are times when even the best-tempered people can get on each other's nerves under such conditions; so anyone who is hard to get along with, surly or unpleasant isn't suited to submarine work. And, of course, if anyone is



An experiment in the chemistry lab. The student watches while the Chief performs the experiment with the mixer.

found to be suffering from claustrophobia (fear of being confined in a small space), he definitely cannot be a submarine man.

All this may sound a little on the gloomy side, but the percentage of men who are dropped for these or other reasons is so small as to be negligible. They are factors which have to be considered for special work, such as submarine duty, and they enter into the over-all picture of training the submarine sailor.

As for the courses of study, they are mechanical and technical in nature. Most of the students at the Submarine School are high-school graduates. Some have higher education. Others have been to service schools. While the courses call for study and concentration, they are not beyond the intelligence of the average young American who has graduated from high school. A degree of liking for mathematics is a great help, as is a good mechanical aptitude. Those who do not possess these qualities would not be attracted by submarine work.

In the beginning, the students are given textbooks and notebooks. These are made up at the school, and are constantly undergoing change and revision as equipment and tactics are changed and revised. The exact nature of what is contained in them is not available for publication or scrutiny by others than submarine students.

At first, the student is given the preparatory general course, which covers all phases of submarine operation and maintenance, so he understands the jobs going on around him as well as his own task.

When this course is over, specialization begins, and the student pursues his choice of specialty under the teaching of a chief petty officer.

“Why do we want to be in submarines?”

The boys look at each other without answering at first. They seem to be a little puzzled by the question.

“You get on ’em cause you think you’re gonna like ’em,” says the tall machinist’s mate from Arkansas. “And when you get there, you do like ’em. Guess the reason I volunteered was that I heard them called pig boats, and I used to raise razorback hogs in Arkansas. So I just naturally went for this outfit.”

The young signalman from Pearl Harbor takes up from there. “It’s a man’s job,” he says. “The way I look at it, everybody on a sub has got a big responsibility. I like that. It gives you a chance to show whether you’re any good or not. You’re just another gob on a battle wagon, but you’re important on a sub.”

An engineer’s mate, a little older than the rest, says, “The work is interesting. There’s a lot to learn, and you can keep at it as long as you’re in the service and still not know it all. It’s the kind of work and life that you can make a career out of. Fellows in other branches talk about the Navy preparing them for the future. With us, pig boats are the present and the future both.”

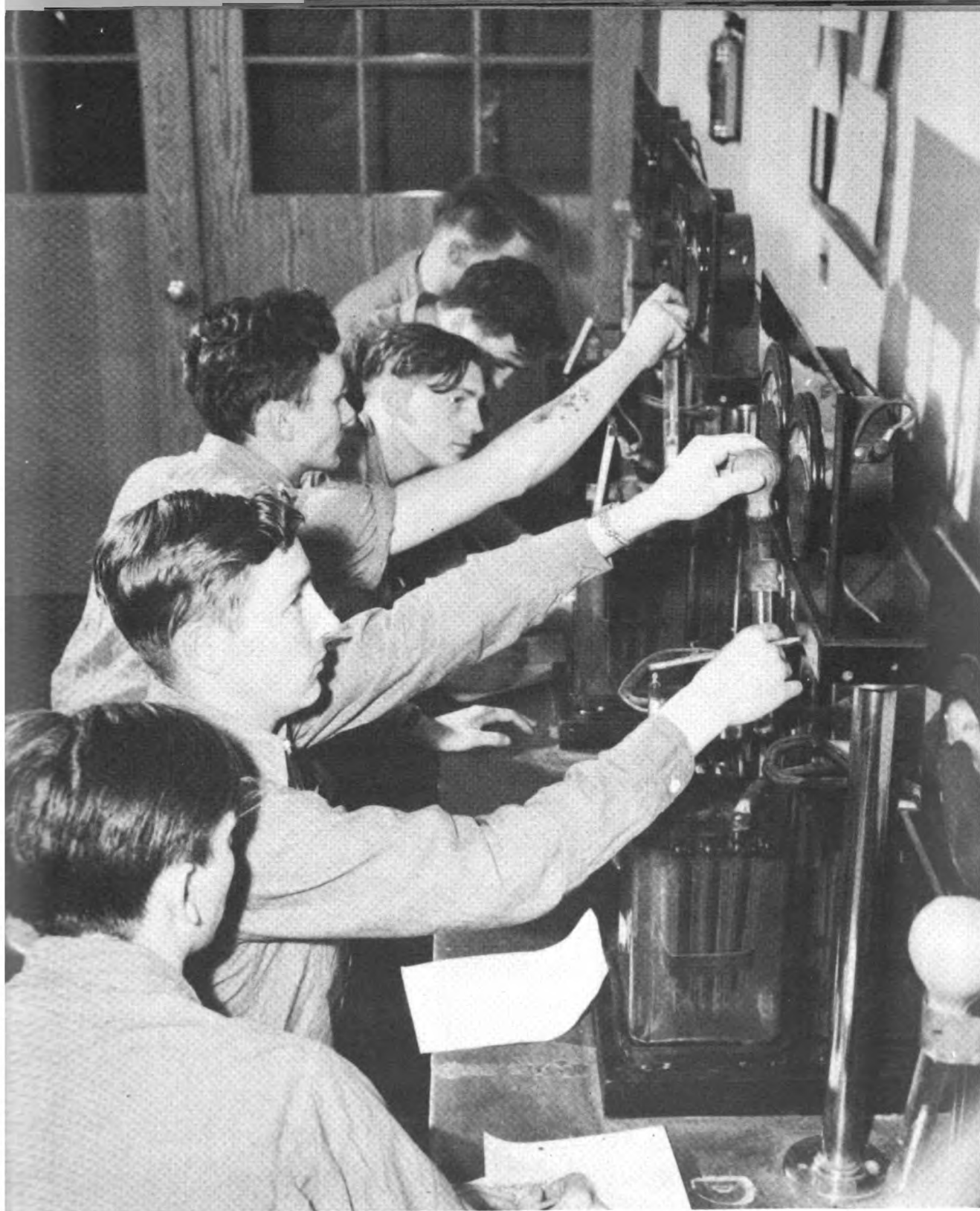
A torpedoman, compactly built, with alert eyes, smiles as he gives his viewpoint. “I’ve handled the fish on a destroyer. There’s a terrific kick in letting one of those babies go when the enemy is trying to pierce your ears with six-inch shells. There’s a lot of the hunter in me. Used to like to hunt a lot before I joined up. Always thought I’d like to hunt big game. This is my chance. They don’t come any bigger than battle wagons. And when you get one of those on your first shot—hell, it’s just about the biggest thrill in the world.”

"Submarine work is different," says a radioman. "It's different in the same way flying is different. Everything about it is interesting, and not like anything we've ever done before. Then, most of us guys are anxious to get a crack at the enemy as soon as possible. We know that in the subs we don't sit around and wait for the fascists to swing at us. We go out and swing first—and that's okay by me."

"I made a bet when I joined the Navy that I would never see the world through a porthole," says a gunner's mate. "I volunteered for submarine duty to win that bet. I've been all over, but I haven't seen anything through a porthole—or any other way. The skipper at the periscope, he tells us where we are. 'Sailing past Japan, cherry blossoms not blooming. Sailing past the coast of France—any of you fellows want to wave at a pretty girl?' That way we don't have to see what's topside. The skipper tells us, and we save money by not having to go ashore."

The Chief, who is sitting around with the group, smiles broadly. "A good bunch of men," he says in a low tone, while the others are digging up a few stories. "They've got the spirit and the will to work and learn. Not a tight nerve or a twisted complex in the lot. And don't let this kidding give you the wrong idea about the boys. They're deadly serious about their work. They study hard and put everything they've got into it. They're proud to be serving their Uncle Sam, and they are so proud to be submarine men that they almost grow feathers. But you won't find them crowing about how good they are. They'll always turn that kind of question aside with a joke.

"I know a story—supposed to be true, and I wouldn't doubt it, because I know others just like it that are true. About a cook on one of our pig boats. A cook isn't usually



Testing specific gravity of batteries, the heart of the submarine.

thought of as brave, or heroic, or anything else. A lot of people think he's sort of the comic relief in the services—a guy who can't do anything else.

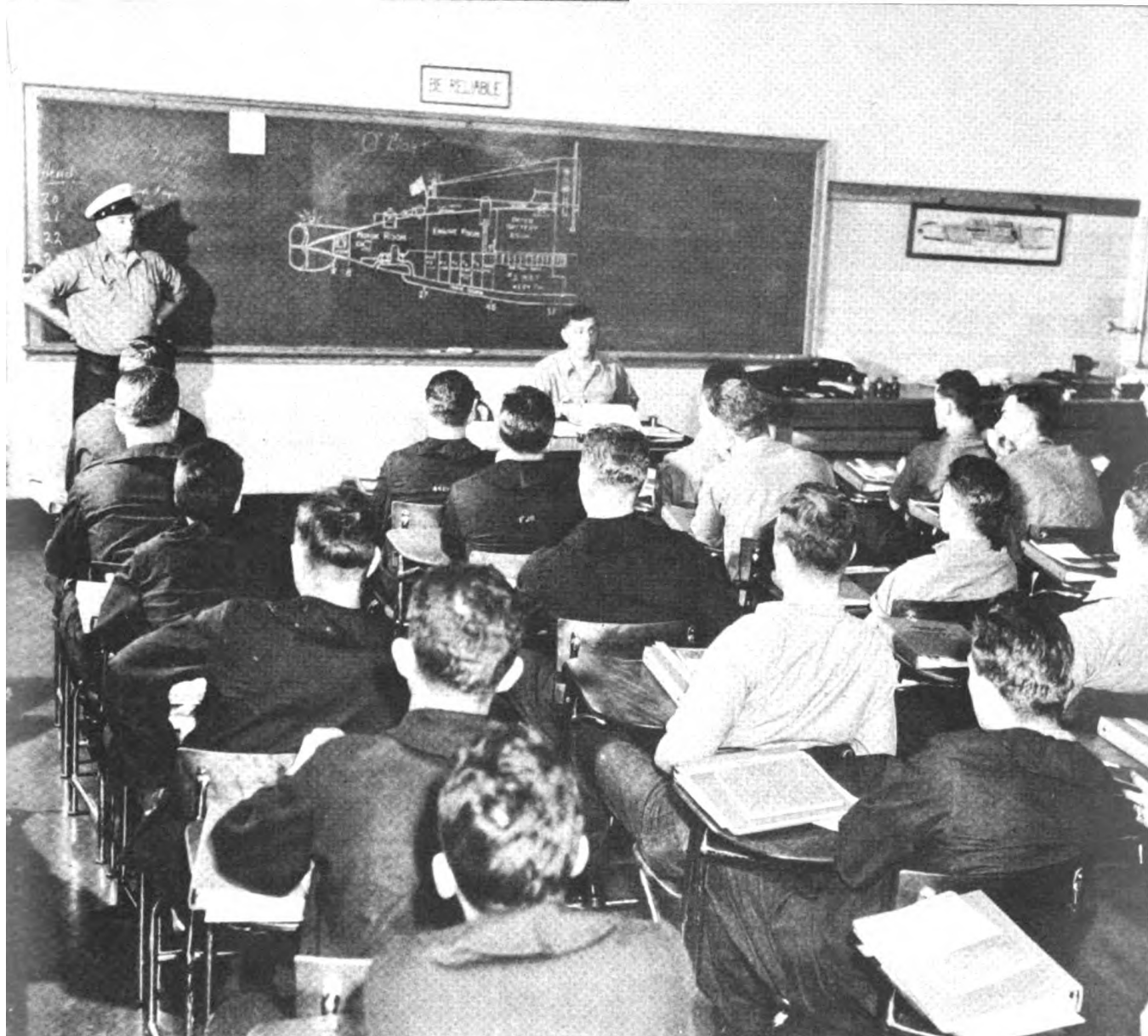
“Well, this cook I'm telling about was also part of the deck gun crew, but he'd never had a chance to do any shooting. Every time there was any action, it was his turn to be riding the electric range. One day, however, the boat had to surface during the daytime to make some minor repairs. The cook and some of the others who were off watch went up on deck to get some air and look around. While they were surfaced they were spotted by an enemy plane on patrol, and it started to attack them. Well, the boys took to the guns, and started throwing lead at the patrol plane, with the cook right in there with the others. The plane machine gunned the boat, and knocked the gun crew over.

“The cook jumps over and starts lugging the wounded to safety, putting them in the gun access trunk, which is right behind the deck gun. Then he starts battling with the plane again, and manages to drive it off.

“The sub couldn't submerge yet, and the boys worked like mad, knowing that the enemy would be back again soon. By the time repairs were made and the batteries were charged, the enemy was coming back again, and the sub was just able to get under before the fireworks started.

“The skipper pointed his nose at the bottom and took her way down, changing his course every few minutes to lose the enemy. But they started dropping depth bombs all around, so he dropped to the bottom and sat there quietly, while all hell broke loose.

“The depth charges were booming away on all sides, and when they'd come close, the sub would shake and shiver,



A class in submarine construction, studying an "O" type of boat, which is used to train students at the New London school. The two words above the blackboard, "BE RELIABLE," are the two most important words a submarine sailor can learn.

like it was going to crack into a thousand pieces. Some of the close ones would make her jump, and then the lights would flicker, and it seemed that the end had come.

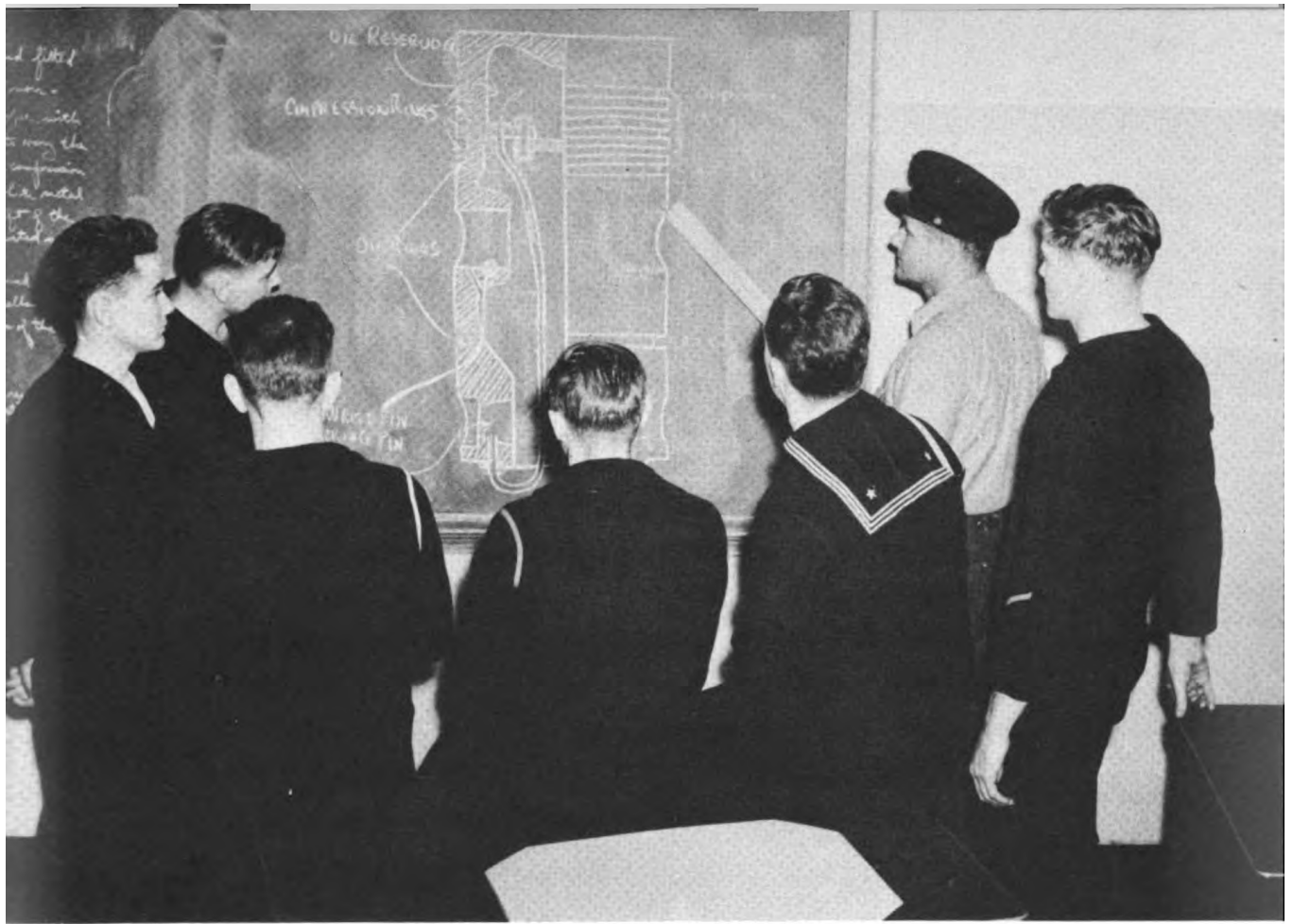
"Right in the middle of the attack, when things were the hottest, and the helpless feeling of sitting on the bottom was beginning to wear on some of the boys, the cook passes around with some hot coffee, and that sort of takes the edge off everybody's nerves. The ashcans are still rocking the sub when the cook takes some coffee to the skipper. The skipper takes it, drinks, and makes a face. The cook looks horror-stricken. 'I'm sorry, sir,' he stammers. 'I forgot you didn't use any sugar. I guess I must have been excited.' "

The Chief gets up, and the others follow his example. Afternoon classes are about to begin. The students split up in groups and head for their work. Some are going out on practice dives, others are headed for the classrooms and laboratories, where they are learning all the tricks of their trade, and becoming expert in their chosen line of work. Machinists, electricians, radiomen—they all troop off to study and work.

The machinist's mate is primarily concerned with the operation and care of the Diesel engines which provide surface motive power for the submarine. The size and power of these engines depend, of course, on the type of boat.

Diesels, today, are the most efficient type of engine for this purpose. Besides providing power for surface operations, the Diesels are also used to supply power to the electric motor which acts as a dynamo to charge the submarine's batteries.

The first submarines built were propelled by oars be-



Martin Sheridan

A smaller class of machinist's mates learn about the Diesel engines they will have to be responsible for when they graduate from the school and are assigned to a submarine.

neath the water, and by oars or sails while on the surface. Later the oars became screws, still operated by hand. Steam and gasoline engines have been tried, but none was as efficient, safe, and fitted for the purpose as the Diesel.

The student who is becoming a machinist's mate learns, first of all, the theory of the Diesel, the design of American and other Diesels, and the different sizes in which he is likely to encounter these engines.

Lectures, diagrams and blackboard work are combined in the theoretical course to give the student an excellent background for his practical work.

In the meantime, practical work also starts. In the school workshops and laboratories, there are a number of Diesel engines. The student takes the engines apart and puts them together again, until he can do it in his sleep. By the time he is through with this course he is a first-class Diesel mechanic, and can be depended upon to keep his engines in good order, and fix them quickly when they get out of whack.

Without electricity, there could be no modern submarine. It is electric power which drives it under the sea, which furnishes the power for light, communications and even cooking. To watch over this heart of the submarine, there are the electricians, functioning under the engineer officer as engineer's mates.

The reason why submarines need two kinds of motors, combustion and electrical, is quite simple. Combustion engines need air in order to function. Therefore they are good only on the surface.

The electric motor, on the other hand, can function

under water in a submarine. But the electric motor depends upon its batteries, which, if they are not charged after use, will run down. The submarine electric motor must also be such that it can be used as a dynamo, and by using the power generated by the Diesels, recharge its own batteries. This can be done only on the surface, and therefore the time a submarine can stay below the surface without coming up to charge the batteries is limited. Hence the need for the two types of motors, and the need for good electricians to look after the electric motors.

Students taking this course also have a mixed instruction of theoretical and practical work. Submarine electricity has many problems particular to itself, which must be learned. One problem which was always the plague of submarines was the fact that acid batteries, when wet, gave off the deadly chlorine gas. Alkaline batteries do not. The student must know how to work with acid batteries, always anticipating the time when he will be in a position where he needs to know about things which he might not run across in the ordinary course of events. An illustration of the importance of batteries is seen in the fact that they comprise 16 per cent of a sub's weight, while the main engines are only 8 per cent.

Submarine wiring and electricity in general must be known as thoroughly as a shore electrician must know how to go about installing or repairing electrical equipment in a house. It is definitely a specialized course, involving a detailed knowledge of submarine construction. Working with the batteries is a job in itself, and on the submarine the electricians have specialized jobs to attend to during different operations. But even though the student will have

one job when he graduates, he must know them all in his line, and be able to do any work needed on the electric motors and equipment.

Under the heading of electrical equipment are the radio and sound apparatus, and the listening devices. Because it seldom has eyes, and must often travel blindly under the water, the submarine has good ears. The oscillator is both ear and tongue, when the need arises. The oscillator is efficient because sound waves travel more efficiently under water than in the air. The oscillator is a large diaphragm, which is submerged, and which deflects inwardly from the pressure of the water against it. When a sound wave strikes the diaphragm, the deflection is increased, and then goes back to normal until hit by the next sound wave. These sound waves can be transmitted into a telephone and amplified, enabling the operator to hear them. The oscillator can tune out such sounds as rain, or the sound of its own sub's motors.

In this way, the approach of a ship can be picked up, the location and direction established, and even the speed ascertained. Because various types of ships have distinctive sounds when heard under water (something else Robert Fulton discovered), the submarine men can often identify a ship without even seeing it, and know practically everything but the color of the captain's hair without ever coming to the surface.

Fans, blowers and pumps are also operated by small electric motors. In all, there are over two hundred major parts to a submarine, and most of them are affected in one way or another by the operation of the electric motors.

Submarines are also equipped to avoid striking the bottom when traveling blindly under water. For years, surface

ships as well as submersibles have been equipped with devices which recorded the presence and distance of anything under the water such as a hidden reef or a shallow ocean floor.

A submarine, therefore, means electricity, and the men in the engine room are important. It is easy to see why the men in a submarine have to know that they can depend on their mates, and why it is the policy to keep one crew together as much as possible. It's the old story of a good team that has played together being better than a team of good individual players who are together for the first time.

On a submarine, every man knows something about every operation, besides his own specialty, and these things are learned at the school. The kind of flag waving the students practice has nothing in common with the Fourth of July politician, but is part of the signaling system used by the Navy. Semaphore drill is a part of the signal course, as is drill and study in buzzers, blinkers and radio. In one of the classrooms, every desk is fitted with a sending key; and the students, brows furrowed as they sit attentively in their blue dungarees, click away at messages as they prepare for the real thing. The signalman on the submarine will probably be a student who has already gone through a Navy signal school, but the others go through the course to know how, in case they ever need to take over.

Under the general heading of operations comes the use of submarine weapons—the sting and fury of the submarine. Torpedomen, gunners, mine layers, machine gunners—these are the fighting men whose skill make the submarine the dread menace to surface ships.

The submarine, as it has often been said—and will be said more often—exists for the purpose of getting the war head of its torpedo against the side of an enemy ship. Broadly, that includes torpedoes, mines and guns. Except for the gun, the submarine's weapons were born for it, and they have developed together through the years. How they have arrived together where they are today is worth looking into, for it helps explain undersea warfare and the men who fight it.

Because it is the oldest submarine weapon, the mine has seniority rights to first mention. Its principle is fairly simple—to leave a powerful explosive floating around where the enemy is likely to sail, so that he will hit the mine and be blown up.

The ancestor of the modern mine is probably the old fire ship of ancient Rome, when such ships were set afire and launched to drift into the middle of the enemy fleet.

Although the Chinese are said to have used gunpowder only for firecrackers until the Europeans came along and found it well suited for war, it is known that the Chinese had land mines about 100 B.C., and it is believed they also may have used sea mines to protect their harbors.

However, when powder was brought to the Western World and used in warfare, it was only logical that someone should think up the idea of the mine—the floating explosive which could sink any ship that came in contact with it.

The trouble with mines, however, was that they had to be set off by the attacker. If you could sneak the mine over to an enemy ship, fasten it, light the fuse and get away without getting shot, there was a chance for success, but not much.



Martin Sheridan

On the surface, after a long period of submersion, this sailor can open the sub's main vents, letting in fresh gusts of salty sea air to make the interior of the boat more comfortable.

A historic example of such an attempt was the unsuccessful sortie of the American submarine *Turtle* against the British ship *Eagle* in the Revolutionary War.

When timing devices were made to work, the mine became more useful. By the time of the Civil War, mines were advanced enough to be fired by electricity, with the aid of a cable, and later the mine was developed to the point where it could be set off by direct contact.

The mine now is a globular metal ball about three feet in diameter, containing up to four hundred pounds of explosive. When laid, the mooring, or stationary mine, has an anchor and cable, which are adjusted to keep the mine at a certain specified distance under the surface. On the buoy, or explosive part of the mine, there are a number of horns sticking out in all directions. If one of these is hit and broken, it breaks a glass tube inside, acid runs down to the battery, making it alive, and causing the explosion of the detonator and the mine.

There are various types, sizes and shapes of mines, but they all have the same purpose—to sink enemy ships. Mines are used offensively to blockade enemy ports or endanger their shipping lanes. They are used defensively to block enemy ships from approaching friendly or home ports.

Mines are usually laid in “fields,” in such a way that a ship passing through an area well sown by mines must sooner or later strike one.

Because it can approach unseen, the submarine can often lay mines and thus trap and sink enemy ships where it would be impossible to attack with the torpedo. Recently, when a few ships were sunk off the American coast, it was attributed to enemy mines, because the struck ships were traveling in a convoy of naval vessels in an area where the

presence of a submarine would have been easily detected.

In the first World War, more ships were sunk by mines than by any other weapon. In the present war, mines and torpedoes have proved to be the most deadly of all weapons.

That, then, is the task of submarines equipped for mine-laying. While defensive mines are usually laid by surface ships, enemy waters can often be approached and mined only by the submarine or the mine-laying airplane. Of the two, the former has a better chance of being undetected.

He's going to be a torpedoman. He's going to ride herd on the smashingly powerful "tin fish," the most dreaded weapon in the war at sea. He's going to win the right to wear the white torpedo insignie on his sleeve—an insignie telling the world that this slender, quiet-spoken boy may be the one who launched the torpedo which helped change the balance of naval power in the Atlantic or Pacific.

In company with a group of other embryo torpedomen, the student reports at the torpedo room, where his instruction begins. They move down the hall together, notebooks in their hands, and into the large room where a torpedo is on the table for study purposes.

Here the terror of the sea lies, its polished metal sides gleaming in the light. The student feels dwarfed by the huge engine of destruction, and awed by its potential might.

Someday he's going to handle these fish as though they were minnows. He's going to know them inside out—all their tricks and capabilities, and their strange, obstinate whims. Now, notebook clutched in his hand, he stands a respectful distance, and looks at them with a wondering eye.

The submarine torpedo at which he looks is twenty-one inches in diameter, but it looks larger. It weighs 2500

pounds, and has enough power to blow a battleship out of the water.

It's complicated. The student looks at the motors and the parts that jam one section full, and he scratches his head. The equipment takes up as much room as an automobile engine, but it's a dozen times more difficult to figure out. When properly adjusted, the torpedo can be made to do almost everything but determine the nationality of the ship at which it is fired.

The student draws a long breath, and turns to one of his companions. "Some fish," he says in a low tone.

"It's no BB shot," says the other.

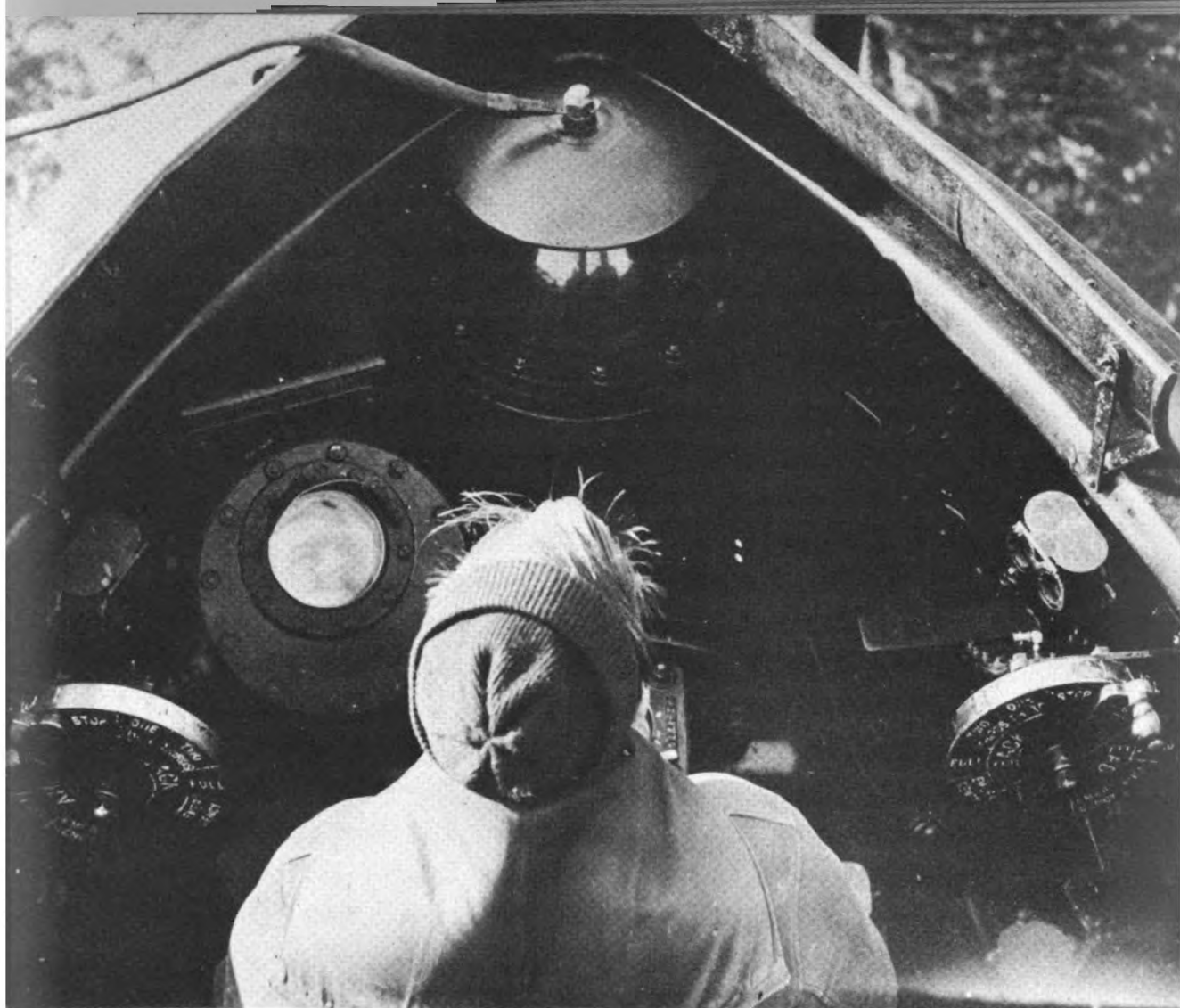
"I never thought they were so big," chimes in a third. "I always had the idea you could tote one around on your shoulder. This thing's almost as big as a pig boat."

The Chief who is instructing the group overhears the last remark. "They have a lot in common," he says. "You'll find that out by the time you've finished this course. But your main job will be to load and fire these torpedoes. And that's a job in itself. Now, if you fellows will just gather around a little more closely, we'll go over the whole torpedo quickly. After today, I'm going to start asking you the questions."

The students grin and crowd in. The Chief leads them from one section of the torpedo to another as he explains:

"The torpedo is divided into three major sections—the head, the center section and the tail. The head contains the explosive, the center section the compressed air, and the tail holds the motors and steering mechanisms."

The student looks at the torpedo with renewed interest. Somehow he had always had the idea that torpedoes were filled with explosive, and were shot the same way a shell



Martin Sheridan

A sailor on the bridge steers the boat after it has come up from a dive and is proceeding home on the surface. All essential instruments and controls are found both on the bridge and in the interior of the boat.

was fired from a gun. But the torpedo is no mere bomb, or shell—it is a real hunk of machinery.

For the rest of the class period, the Chief explains the torpedo. For the rest of the course, the students work on them and with them.

The head of the torpedo is shaped like the nose of a shell, but is only three quarters of one tenth of an inch thick. Its mission is not to penetrate, but to work in another way. To get that picture, let's jump ahead and watch the torpedomen and the torpedoes in action.

The sea is choppy and rough, with a stiff wind kicking up millions of whitecaps. A Nazi cruiser is seemingly the only ship in all the North Atlantic. It steams along at half speed, drenched by the flying, stinging spray. Her decks are deserted, and she is stripped for action, the huge gray muzzles of her guns threatening sea and sky as the ship rolls. From her bridge, alert officers and men scan the sea constantly, seeking the first sign of an enemy.

Unseen among the angry dull waves, a slim periscope cautiously breaks the surface for a few seconds, then slips down beneath the waves again. The cruiser still keeps a steady course, confident that she is alone.

But she is already being stalked. Breakfast has just been finished by most of the crew of the submarine when the man at the listening apparatus calmly reports the sound of motors. Just as calmly, speaking in an even tone that belies his inner excitement, he reports the motors as seeming to be those of an enemy warship.

The word he flashes to the skipper becomes known to every man of the crew. They are on their way to their stations even as the alarm is sounded, sending them to battle stations. The quiet, efficient operation of the sub-

marine does not change as the men go to their stations. But somehow the air has changed. Where a moment ago it was relaxed, it now seems charged with electricity. A grim tenseness, made the more impressive by the heavy silence, grips the entire boat. The men stand at their posts silently as their craft begins stalking the cruiser. The whine of the electric motors increases as the boat goes full ahead.

While the periscope is up, the skipper gets the range and course of the enemy ship. Quickly the officers figure out how to smash her hull with a torpedo, and the firing course is given.

Up in the forward torpedo room, the "torps" are ready. As they get their instructions over the internal communications system, their deft hands are "instructing" the torpedo. Swiftly they turn the dials that will direct its mechanical brain.

The torp's hands are steady as he goes through the motions he has practiced so many times, but his heart is beating much faster. The real thing at last.

He helps trundle the torpedo into its tube, and then, with his mates, stands by for the firing order.

Seconds pass. A nervous sailor has to clear his throat, and the sound is like thunder. The others glare at him, but say nothing. Silently the sub slips along, getting to the point where it will attack. The seconds drag like hours. The torp stands at his station like a statue, his muscles tensed for immediate action. He half holds his breath, waiting for the sound of depth charges to bounce around his ears.

Suddenly a voice crackles in his ear over the battlephones.

"Fire one!"

"Fire two!"

At these commands the chief electrician presses the

button that sends the torpedoes on their way. The torps hear the thud of the compressed air charge as the first torpedo gets away. The boat shakes as the two fish go speeding away.

Again seconds pass. Then the sound of depth charges as the cruiser sees the attack. But the depth charges are a futile gesture. It is too late to counterattack or to dodge. The men on the submarine let go their breaths as they hear two mighty explosions, and their boat rocks from the impact.

The skipper risks another look. The cruiser is going down. Two direct hits have broken her apart. Suddenly the calm and evenness of the submarine are broken. The torpedoman throws back his head and emits a long howl of victory. Others are pounding each other on the back, shouting into one another's ears. An enlisted man rushes up to an officer and pumps his hand. The officer slaps the man on the back, and they laugh. For a few minutes the scene is one of wild rejoicing. Only the men who are operating the boat keep their feelings down, remaining at their stations. But even they let out their own howls of joy.

The tension is smashed as the men give vent to their feelings. The moments of silence and waiting, always the hardest, have been well rewarded. The slim craft rises to aid survivors, then reports her victory to friendly surface ships.

In this operation, the like of which has happened hundreds of times in this war, science and skill have blended to make a deadly stroke possible. The torpedo has sunk about seven out of every eight ships sent down in this war. No other weapon approaches it for the damage it can inflict on the enemy.



Martin Sheridan

The wet sides of the pigboat gleam in the sun as it comes up
from a dive.

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It is an intricate machine of destruction, with some 1300 precision parts. It costs about \$12,000 to build, but it can send a \$40,000,000 ship to the bottom with one tremendous blow.

It carries everything it needs to get it to the target. First, the torpedo is adjusted; its depth is fixed. A torpedo can be made to travel at any desired depth by adjusting a hydrostatic valve. It is most effective when it strikes below the water line, and usually travels at twelve or fifteen feet below the surface.

When the torpedo is fired, it is shot out of the tube by a charge of compressed air. As soon as it hits the water, its own motor starts functioning. The huge center section of the torpedo is an air flask containing up to 2000 pounds of compressed air per square inch. Jets of compressed air furnish the power for all the work that is to come.

As soon as its propellers grab hold, the torpedo levels out at the correct depth, and charges for the enemy like a bull on the rampage.

To push it on, a jet of compressed air shoots back into the combustion pot, while another jet forces a fuel such as alcohol into the pot also. This combination forms an inflammable spray which is ignited.

The torpedo is kept on its course by a gyroscope that is operated by compressed air. Any deviation from the course immediately causes another jet of air to work a small motor which forces the torpedo back to its correct course by operating its rudders.

A similar mechanism takes care of keeping the deadly fish at its proper depth. Should it rise above or sink below that level, an air jet starts a motor which works the horizontal rudders, correcting the depth.

It is the small servo-motor that is the jack-of-all-trades in the torpedo, and keeps it to proper course and depth, counteracting the pressure of the water on the rudders and fins of the missile.

As the torpedo speeds through the water, the wake showing its presence is caused by the air bubbles which are released to work the motor. A fast ship, seeing these in time, may be able to maneuver and escape. That is why torpedoes are often fired in pairs, or in threes, in order to trap a faster ship.

When the torpedo strikes, the pointer, or striker rod, is forced back, setting off a small charge of fulminate of mercury. This in turn sets off the main explosive charge, TNT.

When the latter lets go, it creates 17,000 times its own volume in gas, and this gas wants to spread out pronto. Spreading out, it delivers a punch that rips at everything within reach. Its main force is carried by the water in which it explodes, the water becoming a terrific battering ram, smashing against the hull of the ship with violent tons of pressure. Often, the explosion also rips a hole in the side of the ship. Hitting right, the torpedo exerts enough pressure to lift a ship out of the water, its plates buckling, seams sprung, and its back sprained or broken. Enough, at any rate, to start the ship toward the bottom.

Those who wonder why aviators bother to talk about near misses when they are bombing ships, will find an explanation here. A huge bomb dropped near a ship works like a torpedo, and may deliver a more deadly punch than a direct hit. The least it can do is weaken the bombed ship, so that it has to go into port for repairs before being able

to come out and fight again. And that takes it out of action for a time, at any rate.

Coming back to torpedoes, it is a fact that without them submarines would not be the terror of the sea they now are.

As long as there was no way to shoot explosives under the water, submarines were limited in use, and their development was slow. In the early days, it was necessary for the attacker to tie his bomb to the enemy's tail, in effect, set it off and then run for it. At best, this was ineffective.

The solution, as practiced in our own Civil War, was the spar torpedo. It consisted of hanging a mine or other explosive on the end of a long pole, and ramming it against the enemy ship.

The craft used to operate the spar torpedo were a type of submersibles. Actually, they floated on the surface, and could not dive. But they were built so that all the ship was under the surface, with only the top showing, and the ship looked like a floating plank. These submersibles were easy to spot, and made good targets. In addition, they were hard to get out of, and were always sinking, drowning their crews.

In 1862, however, an inventive Scotsman named Robert Whitehead constructed an "automobile" or self-propelled torpedo after the ideas worked out by a Captain Luppis, of the Austrian Navy. This torpedo weighed 300 pounds, had a compressed-air motor, and carried a few pounds of dynamite at a speed of six miles an hour.

With such a weapon, the full possibilities of the submarine were seen. If the undersea attacker could actually "shoot" at an enemy while hidden under the water, he had an advantage that was staggering.

Nations began building better submarines and better



Martin Sheridan

Looking aft at the last hatch—the “rumble seat.”

torpedoes. In 1904, the Japanese used torpedoes against the Russians at Port Arthur with some success, but it was not until the war of 1914-18 that the torpedo became the scourge of the sea when employed by the Germans on their U-boats.

Today, perhaps even as this is being written, a "torp" is standing grimly by, waiting for the order:

"Fire one!"

At this moment, 2500 pounds of the deadliest weapon on the sea may be splitting the waters as they are hurled at the broad side of a surface ship. As this is written—and read—there may be a terrific explosion beating at the waves, a stricken ship that leaps out of the water and falls back again to sink, and a submarine crew that greets the perilous moment with the enthusiastic din of victory.

In the classroom, the Chief has given his students their introduction to the torpedo. The first class is over. The student torp leaves the classroom and walks down the hall. Already, in his mind, he is sending a deadly fish swimming on its way. Before he leaves the building he has sunk half the Axis ships afloat.

The final weapon of the submarine is the gun. Some submarines carry fixed deck guns, others a disappearing gun. To man these, trained gunners are needed, but the problems of gunnery are the same as on other naval vessels, the only difference being that the crews have to be submarine men as well as expert gunners.

An interesting development on the submarine has been the gun access tower. It used to be that gunners, coming on deck, had to come up through the conning tower. If the sub had to make a crash dive, it dived without them, and

left them swimming in the ocean to be picked up by the enemy.

Now, however, submarines have a hatch at the base of the conning tower, behind the gun. In case of emergency, the gunners can jump into this and close the hatch. Inside, there is a separate chamber, which can open into the main body of the sub. The men can stay in the chamber until the outer hatch is closed, then open the inner hatch and get back into the submarine.

This hatch is also used for escapes. A few men go in, close it off, and let in enough compressed air to counteract the force of the water outside. Then they open the outer hatch and go up the ascent line to the surface, using Momsen Lungs. Once the hatch is closed again, the men in the submarine blow the water out, and a few more make an escape, until all are out.

Besides the men who operate the engines and the apparatus for listening, the torpedomen and the other specialists, there are seamen, firemen, a yeoman (clerk) and a cook. The composition of the crew is so arranged that every man has a specific task during every operation. Even the cook has a station to man and valves to look after when the submarine is diving or rising. There are no extra hands. Every man has a definite job, and if he is not trained to do it well, it will affect the entire ship.

So it is that the Submarine School, each month taking in a new quota of men to complete crews, by lecture, study and practice turns out first-class submarine men. The length of time spent on each course and the things taught are largely naval secrets, and cannot be revealed.

When the student graduates from the Submarine School he does not win the right to wear the dolphin submarine

insigne on his arm. That right must be won in actual operations, perhaps under fire. Any man wearing the dolphin is carrying proof that he has had what it takes to be a top-notch sailor, fair weather or foul, above or below the surface of the seven seas he travels, come shot, shell, hell or deep water.

One of the pleasing items about submarine service which is appreciated by the sailors is the matter of increased pay, which can always find room in a sailor's pocket.

The extra pay is given not only because undersea work is more exacting and more dangerous than other types of service. A qualified submarine man, who has attended school, is being rewarded for a number of things. He is being paid extra because he has something extra to give. He is a skilled member of the armed forces, a specialist, who has had to meet stiff requirements mentally, morally and physically. He has worked, studied and learned, and by his effort he has been able to move himself up.

He is not being paid for his bravery or courage—no branch of service and no man has a monopoly on that, and Americans aren't fighting for dollars. He is getting paid according to his ability, which is fair.

Where there were hundreds, there are now thousands. American submarines, bigger than ever, more powerful than ever, and carrying more punch than ever, are hitting the water in increasing numbers. As they are commissioned, new groups of hardy young Americans step forward, intelligent, trained and eager to take part in the mighty battle.

Someday, in some vast ocean, their knowledge and teamwork will enable them to function smoothly when the orders are called: "Fire one! Fire two! Fire three!"

Alone in the ocean, unseen, tiny, but dauntless, their victory will come, and it will be our victory.

Chapter Four

TRAINING THE SUBMARINE OFFICER

THE TRAINING OF THE submarine officer is somewhat similar to that given the enlisted men. The similarity is in the subjects covered; but the officers, who are already technically advanced, receive a much more thorough and advanced type of instruction.

In addition, officers are trained for the specific tasks of administration and command which they will have to assume on a submarine. Much of the detail about officer training is of a secret nature, but a good picture of that instruction is available.

Officers, like enlisted men, are volunteers. Those officers in the Naval Reserve or on active duty who wish to be assigned to submarine duty, make their request through their commanding officer, and are considered by the Bureau of Naval Personnel.

The choice of an officer for submarine duty is a stricter procedure than the selection of an enlisted man. The training and responsibilities of the officer are such that the candidate must be possessed of the many qualities of personal ability and technical aptitude which are essential for under-sea work.

Officers are given as stiff a physical exam as any enlisted applicant, despite the greater technical requirements they

must have. Their complete record in the Navy is carefully studied by the Bureau of Naval Personnel, and the recommendations of the applicant's superior officers in the past are considered.

If the applicant is considered to be the right type for the work, and seems to have all the qualifications for it, he is sent to a submarine or to the Submarine School.

The procedure is somewhat different for regular and reserve officers. Regular officers, with surface ship experience, used to need at least two years' experience at sea. During this time, they must have qualified to serve as officer of the deck. This is a rotating assignment for all qualified officers on a ship. On the day that he is deck officer, the officer is practically second in command, subordinate only to the commanding officer and the executive officer. All others, even though of a higher rank, are under his orders for the time he is deck officer.

This qualification for regular officers has been modified somewhat during the war.

The reserve officer, upon acceptance, is given an indoctrination course that fits him for active service, and then, as is the regular officer, he is sent to the Submarine School or is assigned to an operating submarine in an assisting post.

During these months, the new officer gets a taste of undersea life and fighting. His superior officers in the submarine observe his ability, and are soon able to tell whether or not he will make a good officer.

In this period, his courage, judgment, adaptability to submarine conditions and ability to assume responsibility are all watched. If, at the end of his trial, for those first sent to submarines, the student officer still wishes to continue

in the submarine service, and if he has shown himself to be acceptable, he is sent to the Submarine School.

By this time the officer is a fairly good practical submarine man. The purpose of the school is to put on the finishing touches, and increase his technical knowledge, preparing him for the day when he will rate a command, even though that day may be far off.

At the start of the course, the student officers go through the escape tower training, learn submarine phraseology, how to handle their craft, and what there is to a submarine base. On actual trips, the student officers take responsible positions, under guidance, just as the enlisted men begin their real duties under the eyes of a trained crew.

In addition to the various positions held by officers, the student officers also take their turn at the jobs filled by the enlisted men. Handling a submarine has much in common with driving a car: all the study in the world won't tell as much as actual handling. Combined study and practice make for top efficiency. So it is that each student officer takes his turn at the diving planes, the switchboard, the motors, the low pressure pump and every other station. He also takes over the duties of the officer in charge of each section, functioning as the diving officer on one trip, the engineer officer on another, and so on. When he has had a hand in every operation, the student officer is ready to give orders in maneuvering the submarine, understanding everything connected with that maneuver.

Although the officers specialize, each one is so trained that in cases of emergency he is able to take over any other job on the submarine, and perform it with reasonable efficiency. The school doesn't expect to turn out geniuses,

ready to command submarines. A good commander is the result of many years of experience, and technical training can only fit him for a certain degree of efficiency. In action, there is no substitute for years at sea in a sub.

The average boat carries five or six officers. They are the commanding officer, executive officer, gunnery officer, navigation officer, engineer officer and communications officer. On large submarines there may be more; on smaller ones a single officer may hold two or more of these jobs. All officers are trained to hold any one of them if need be.

In all departments of study, the officers have a course which consists of lectures, practical work and outside study. At this point it might be well to point out that practically all student officers are college and university graduates, and practically all are graduates of engineering and technical schools. Many have advanced technical degrees. This makes it fairly obvious that the course of study given to student officers limits that course to comparatively few young men in the country.

Although the enlisted course is difficult, it can be passed by the average intelligent young American with a high-school education and a mechanical flair. No bones are made about the complexities of the officers' course. There are instances where men with university degrees other than in technical lines have been able to go through the school, but these are the very rare exceptions.

On the submarine, each officer is the head of his department. The duties of each department are studied by all officers in the school.

The classrooms for officers are in the same buildings as those of the enlisted men. They have separate classrooms, equipped with the necessary tools of learning.

One phase of the course for officers deals with the administrative duties on a submarine. An officer must be a leader of men, and the ability to lead is something which, while it cannot all be learned from books, can be improved upon. Administrative study fits the officer to deal with the particular problems of submarine organization and operation, and makes him ready for all duties and responsibilities his commanding officer may give him when he is at sea.

Here also is given a course dealing with the rudiments of approach and attack. The climax of all training and all experience arrives when the submarine sights an enemy ship and moves in for the kill. It is the moment that every man and officer has been training and practicing for ever since he first started work.

The submarine wins or loses its battle before any guns or torpedoes are fired. If the judgment of the commander is bad, or the crew lacking in ability and training, or the officers slow in the performance of their duties, the quarry can be lost—and so can the vessel.

In every weather, against every kind of foe, the submarine man must be trained to know the best way to approach the enemy, and the most efficient method of attack. Nine times out of ten this will be a torpedo attack. Again, it may be a question of rising to the surface and using the deck guns. It all depends on the time, the place, and the victim. . . . If you have ever done any snap shooting at a moving target, you have a vague idea of the problems facing a submarine when it is to launch an attack.

Most ships are armed, and the submarine is not built to absorb punishment. Even a minor hit might disable it to such an extent that it cannot dive; and a submarine that



Martin Sheridan

Dressed in heavy clothes before going up on the bridge, the skipper (left) and his first officer scan the horizon through the periscopes. If all is clear, the skipper will give the order to surface, despite the rough weather. Submarine officers share all the hardships of submarine life with the men as well as its compensations.

cannot dive is just a clay pigeon to the gunners of surface vessels.

Here, then, is the problem of the submarine officer. In the daytime, the submarine must stay under the surface almost all the time. Because of the toll that enemy submarines take on the shipping of all nations, the rule when encountering a strange sub is to shoot first and ask questions later.

Therefore, the only contact with the outside world is that held by the officer at the periscope, who scans the sea as the sub cruises along under the water. Often a submarine travels deeper, where a periscope cannot be used, and where navigation is a problem for a master.

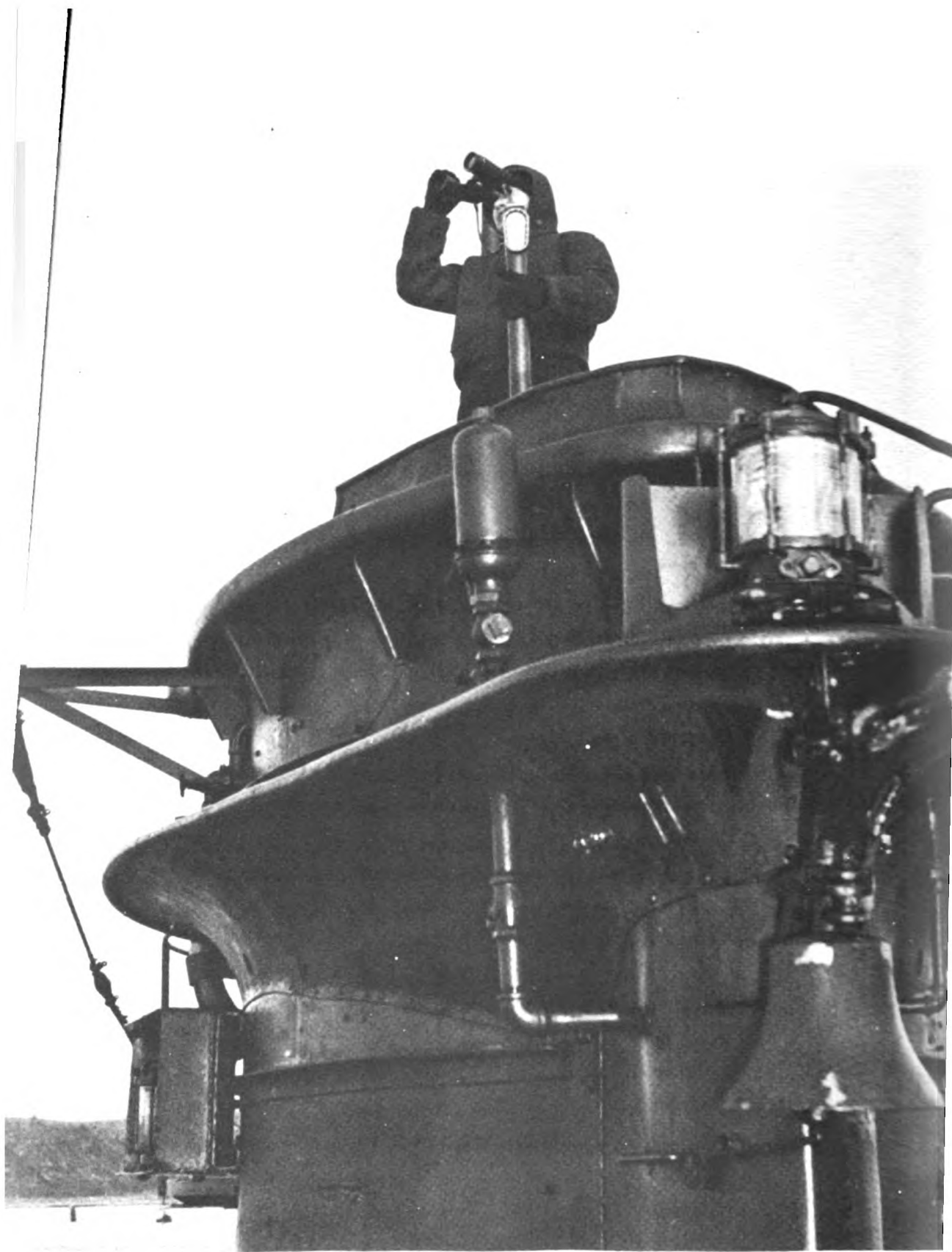
Take a submarine cruising in waters where enemy ships are liable to be encountered. At intervals the commanding officer sings out, "Up periscope," and he sticks the periscope up through the surface. At such a time the speed of the submarine will be reduced to a minimum, to diminish the amount of wake bubbled by the moving periscope.

The periscope goes up and the officer swings it around, scanning the horizon. Miles away, he sees smoke against the sky. "Down periscope," he says, and turning to his officers, he reports the approximate distance and direction of the smoke.

The sub swings around and makes a course that will bring it to the other ship at right angles, and ahead of it, in a position to let go a torpedo if it be an enemy.

Figuring the speed of the submarine, the speed of the other ship, the distance to be covered, and the angle to be taken, is a problem in mathematics to be worked out on the spot.

As he closes in, the commanding officer takes quick



Martin Sheridan

On the bridge, the look-out gazes out to sea through his
glasses before reporting the way clear.

looks through the periscope, pushing it up for an interval of two or three seconds. When the other ship comes in sight, looking about an inch long, and half an inch high, the commanding officer downs periscope and reports that the ship is a friendly cruiser. The sub swings around and goes back on her original course.

But if the ship had been an enemy, all hands would have been at their stations—the torpedomen ready to fire at the signal, the men at the engines, diving planes and rudders ready to carry out the proper maneuvers the instant they were barked.

A simple problem in approach and attack might be roughly this: An enemy cruiser is seven thousand yards away, off the starboard side, and two thousand yards ahead of the submarine. It is traveling from east to west at an estimated speed of twenty-four knots. Traveling at eight knots, at what point will the submarine be able to arrive at a right angle with the cruiser, a thousand yards away, so that a torpedo, from a thousand yards, will strike the cruiser?

In a submarine, the commanding officer, looking through the periscope for a few seconds, would have to be able to estimate the speed, direction and distance of the cruiser. Then, perhaps without daring another look, the officers would have to chart the movements of the boat so they could fire the torpedo without seeing the target, and be reasonably sure of hitting it. And that's a problem!

In all this, speed is essential. Every second a periscope is exposed, there is a chance that some lookout will see the wake and give the alarm. Undersea boats try to get in as close as possible when they fire their torpedoes, so the attacked ship will have less time to dodge the torpedo and

fight back. All this is an increase in danger to the submarine crew.

Obviously, an officer can't be trained in a week to stick a periscope out of the water, look out for five seconds, recognize a ship several miles away, estimate its course and speed, and be able to intercept it. This takes practice, study—and much experience.

It is also important to be able to recognize ships. Our Navy knows the approximate strength of other navies in various classes of ships. To be able to report accurately the sinkings of definite types of ships, whether the names are seen or not, makes a difference in naval strategy for the near future.

The students get into a contrivance that is a partial reproduction of a conning tower. Here they also use the periscope, but in addition to locating and identifying, they also see the objects as enemy ships to be attacked, and under the eye of their instructor have to work out various approaches and attacks on the spot.

In this way, a combat condition can be simulated, and the student gets what amounts to actual experience under these conditions—with the exception that his mistakes will get him corrected, not sunk.

Linked with the problem of approach and attack are the understanding and practice of the weapons of the submarine—torpedoes, mines and gunnery. The officers who go into this department on a submarine must be able to direct the use of these weapons by the crew, calculate ranges and understand fire control and the solutions through weapons of the various types of attack and offensive action. Especially is this true of the operation of torpedoes, which are *the* offensive power of the submarine.



Martin Sheridan

The skipper and first officer are on the bridge as the submarine heads out toward the training grounds. Despite the U.S. NAVY markings, they look like men from another world in their cold weather outfits.

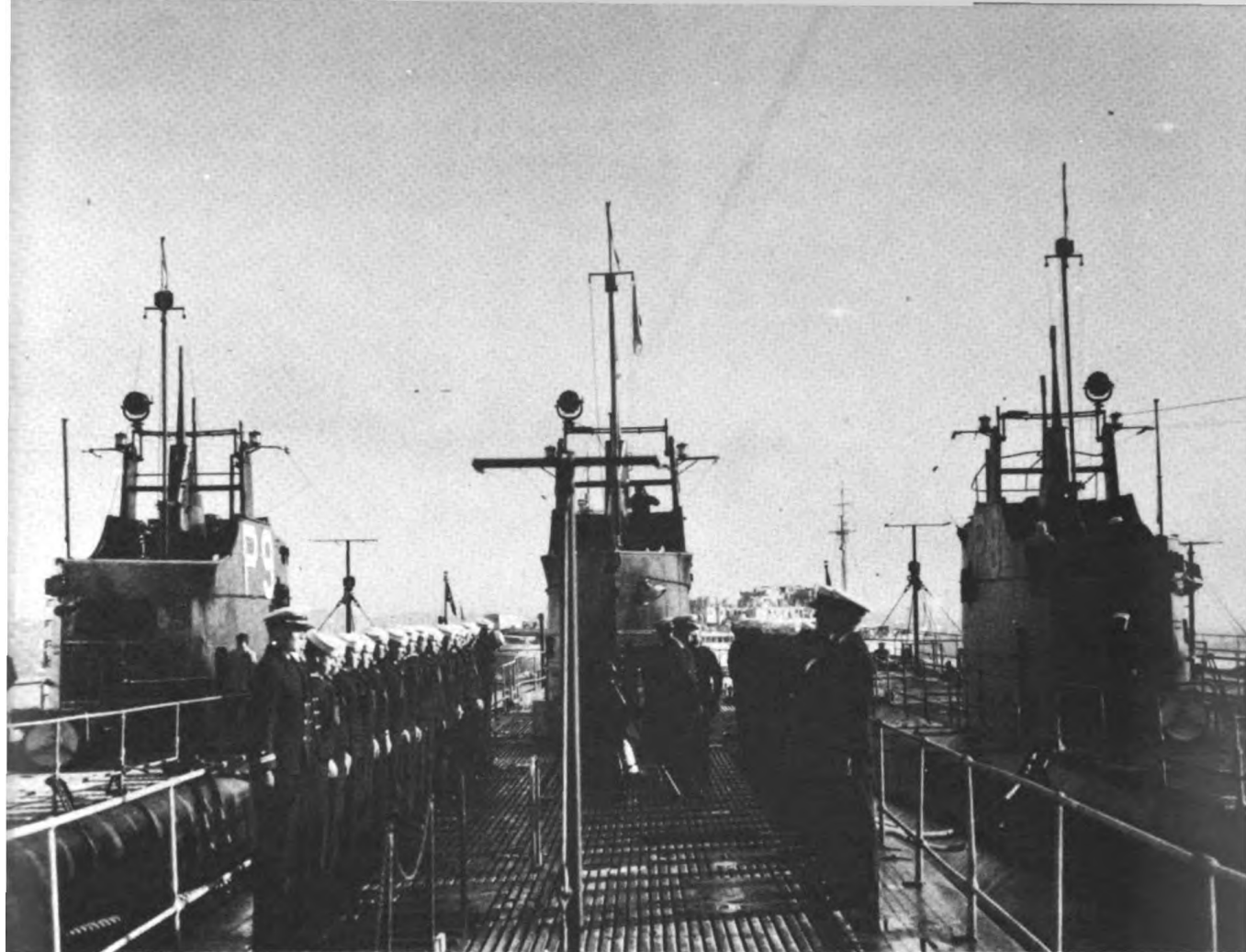
In the engineering department, the officers study the design and construction of the Diesel and electric motors used in American and other submarines. Here again, the officer must be able to take a motor apart, if need be, and also be able to diagnose all mechanical ills. The complete laboratories of the school are used to provide the practical tools for this course of study.

In the matter of communications, the submarine officer has to be proficient in every type used, whether it be radio, buzzer, blinker or semaphore.

On a large surface ship, for instance, the flag officer is on hand to take care of all signaling that has to be done, while the commanding officer only has to worry about what he wants signaled. But a submarine officer, on watch, may be the only man in the conning tower when the sub is cruising along on the surface. A sudden challenge, or flashing of recognition signals from another ship, has to be answered immediately, and correctly. If the officer had to call someone to help him with the signals, the chances are the shot and shell would be whizzing around his ears before he finished shouting for aid. Therefore the officers learn how to handle all the signaling apparatus, and the signals.

Finally, navigation is essential to every officer—surface, submarine or flying. It is the science of knowing where you are when you can't see anything but waves, and being able to sail under the sea for thousands of miles and arrive at the right place. Here instrument and celestial navigation are taught; but inasmuch as the students are all naval officers, they already know at least the rudiments of navigation, and this course is not as strange to them as some of the others.

The entire course, alternating between lectures and prac-



Flanked by two other submarines, the crew of one undersea boat lines up for inspection before the skipper.

tical laboratory work, follows the rough schedule of lectures in the morning, and practical work in the afternoons, although there is no such thing as a cut-and-dried day in the life of the submarine officer student.

While students, these officers have regular base and school watches. During these watches they are responsible for overseeing certain assigned work around the school and the base.

After hours, and when not on watch, the student officers have ample opportunity for relaxation and recreation, both at the school, and in town. Those who are single live in bachelor quarters at the school, while married students can live in town. All students mess together on the Submarine Base.

Upon graduation, the officers are either assigned to operating submarines, or to one under construction. They are not considered finished submarine officers. What they have behind them is some actual service, and a term of school instruction that has combined theory with practice.

The officers are qualified to take positions on submarines under the command of an experienced commander. They have received a thorough training; and from this point on, only experience can further develop them into sea-wise veterans, who may qualify for a command.

The record of American submarines in this war attests to the fact that the men are good, the training is good, and the boats are good. And they are all getting better, which means better able to clear the seas of Axis warships, wherever they may be encountered.

Chapter Five

THE SUBMARINE SAILOR AT WAR

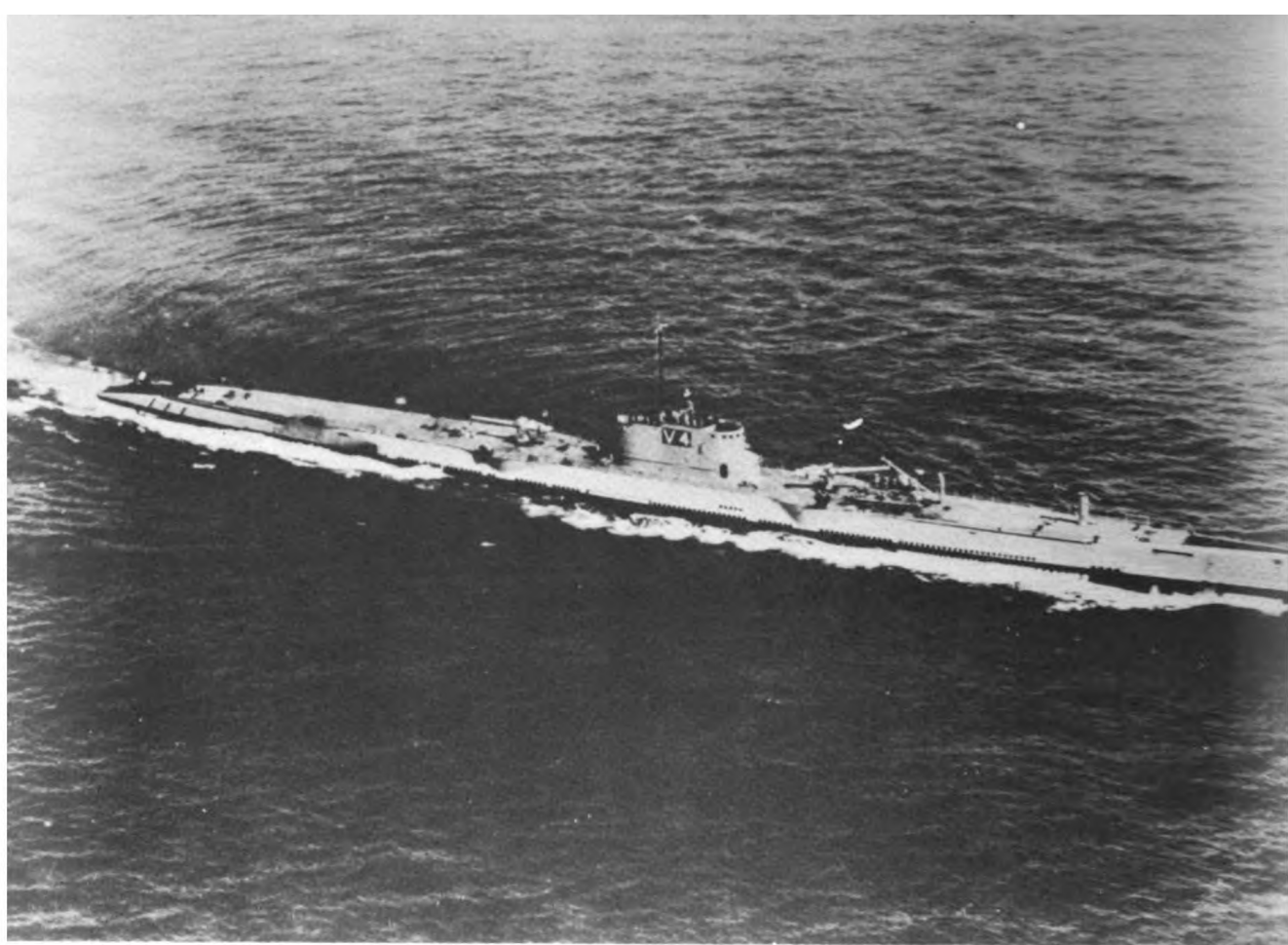
HE'S ON A SUBMARINE now. All the practice, all the classes are over. From now on, it's the real thing. When he next puts out to sea, the guns will be loaded, and the torpedoes will be fitted with war heads. The next problem in attack, for officers and men alike, will be against an enemy, meeting the submarine challenge with depth bomb and cannon.

As he packs his sea bag and prepares to leave the school, he knows a lot about the undersea boats. He knows how they're built, how they operate and how they fight. He knows his duties under every condition. He has taken a boat down and brought it up. He feels at home making a practice escape with the Lung. He has had everything he needs to make him an undersea sailor—in practice.

But until he has been in action for months, stalking enemy ships and dodging enemy attacks, he is still a novice, still not a real submarine man. He yet has to prove himself before the coveted dolphins can be awarded to him to wear on his right arm.

Shortly after graduation, a new submarine, spotless and deadly, gets its finishing touches, and is ready for the sea. The submarine sailor may be assigned to the new boat.

Assignment to this new submarine means active duty.



An aerial shot of the submarine *U.S.S. V-4*. Comparison of this boat with the other submarines pictured in this book will show that submarines come in almost as many sizes and types as do airplanes.

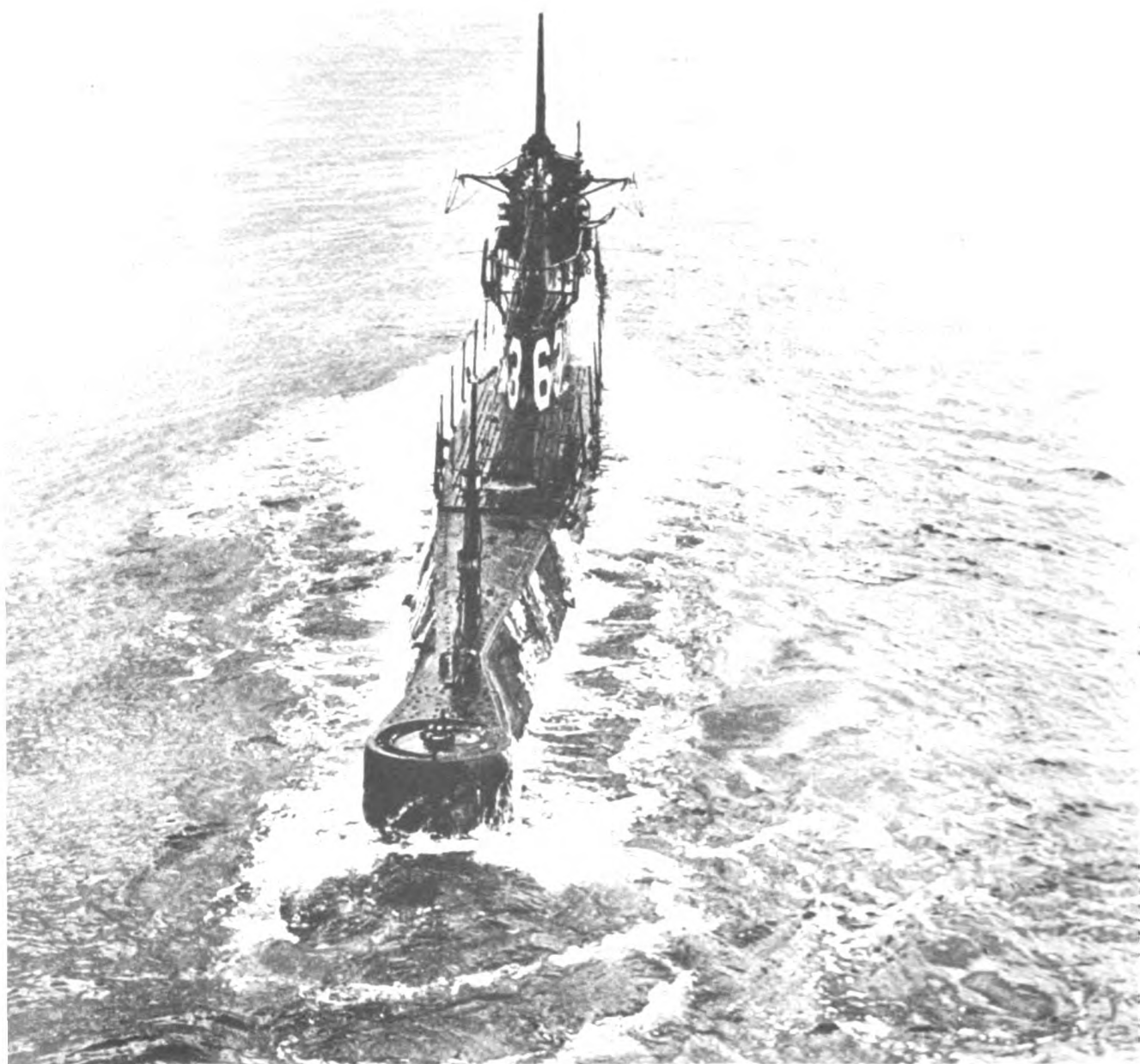
Active duty means slipping out of a secret port in silence and secrecy, with the broad ocean as the hunting ground, and enemy ships as the quarry.

The streamlined submarine is out for a long raid. Thousands of gallons of oil are pumped into her capacious tanks, and great quantities of food are lowered through her hatches to be stored below. Huge torpedoes are stuffed into the rounded body, shining and deadly. Ammunition for the guns comes aboard, spare parts, tools, bedding, clothes, maps, charts, instruments and all the other items, little and big, that a submarine must carry.

The morning she leaves is like the many mornings at the Submarine School. The Diesel engines roar as they are started, and the propellers churn the water of the river as the submarine swings out and away, and heads for the open sea.

But the submarine sailor knows this is no mere training dive. It isn't a matter of being out for a few hours and returning to the base. It is a trip that will cover thousands of miles, and last many weeks. It is a trip that will lead to waters any place in the world—the Atlantic, the Pacific, the Mediterranean—it may be any one of these. It may even be the icy waters of the Arctic. Where it is to be, no one knows. Only when the submarine is well out to sea will the commanding officer open his sealed orders and find out what mission is in store for his submarine.

The sailor takes his last look at shore as the submarine plows toward the open sea. Working smoothly, he and his mates secure everything on the decks, and then go back into the boat. The diving alarms sound, and soon the hatches are closed, and the submarine sinks slowly under the surface, running along evenly at periscope depth.



Hatches still shut, and water pouring from her ballast tanks,
the submarine proceeds on the surface at the end of a dive. . . .

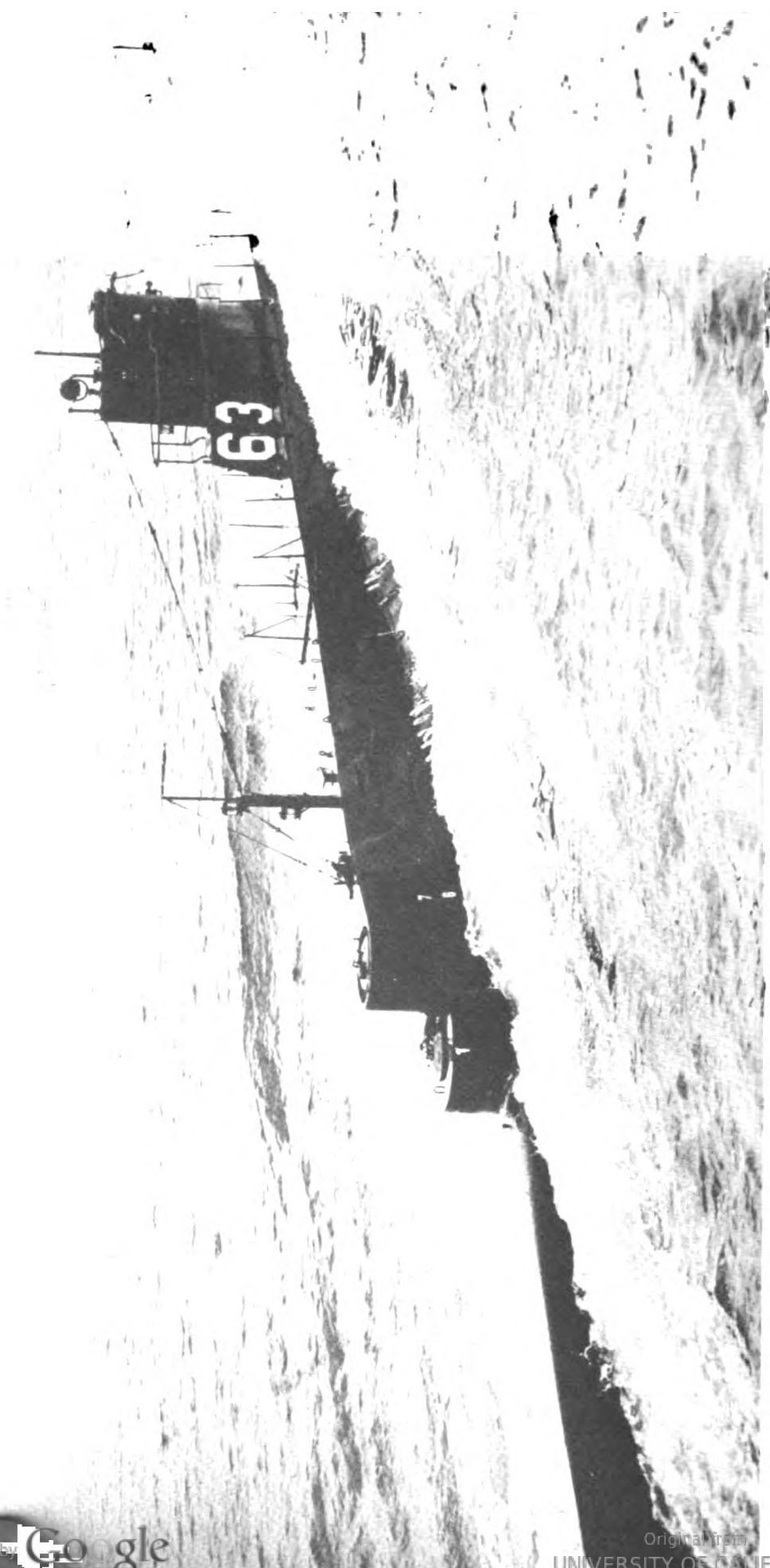
As the boat gets under way, the commander orders her to be taken deeper. The periscope comes down. The whine of the electric motors increases in pitch, and the angle of the submarine tilts slightly forward. At one hundred feet the submarine levels off again. The navigation officer sits at his desk plotting the course. The steersman keeps her to that course. The submarine is on her way.

One reason for running deep is that in clear water, aircraft can spot a submarine running close to the surface. In times of war, the airplane drops its depth bombs first, and gets inquisitive later. To avoid being attacked by his own planes, the commander keeps completely out of sight, and avoids unpleasant mistakes.

Meanwhile, there is constant activity on the submarine. The cook, his duties on the dive over, is busy preparing lunch. Machinists keep a constant eye on their idle Diesels, checking them, testing parts and making sure that they are ready for instantaneous action. Back in the motor room, the electric motors are working well, and the men in the forward and after battery rooms keep a sharp eye on the condition of the batteries.

Other men on watch are polishing and cleaning, keeping their vessel bright and shipshape. The men who are off watch are sleeping, for the most part, while some read, and others talk.

The boat is being handled by a veteran diving section, and the new sailor is off duty. He lies in his bunk and listens to the low whine of the electric motors, feeling his ship threading its sure way through the ocean depths. He knows it will be weeks before he sees the sun again, and that he will seldom see the sky. He thinks about action that may come, and tingles at the thought. He knows from talk-



... And dives again.

ing with the veterans that the thrill of placing a fish against an enemy ship is terrific, and that crews whoop and shout like schoolboys seeing their team making a winning touchdown when they know they have sent out a true shot.

Once at sea, the submarine may have any one or more of a number of missions to perform. Chances are that it will be tender based, instead of shore based, if working with a section of the fleet, and perhaps shore based if raiding alone.

The use of a tender, or mother ship, is important to undersea operations. After days and weeks at sea, the submarine may need more fuel, more torpedoes, more food, or repairs. It is not always possible to return to the nearest shore base where these things are available. Therefore tenders, equipped to supply and even repair submarines, are sent out. They may be contacted at sea, or they may merely lay over in a certain port, where the submarine can come in for supplies. In effect, they are floating bases, and their use allows submarines more time in enemy waters, and increases their efficiency.

It may be that the new submarine going out will receive an assignment held by other American boats in this war. Operating from Honolulu, an American submarine may take a station outside a vital Japanese port, where its mission is to attack, and even to scout. Operating like a scout hidden in the trees—only it is hidden in the ocean—it may lie in wait and watch the movement of Japanese transports, freighters and warships. This information can be relayed to the American command, and be put together with the reports of other scouting submarines which scout other ports. Their combined information can enable the American command to determine certain Japanese plans,

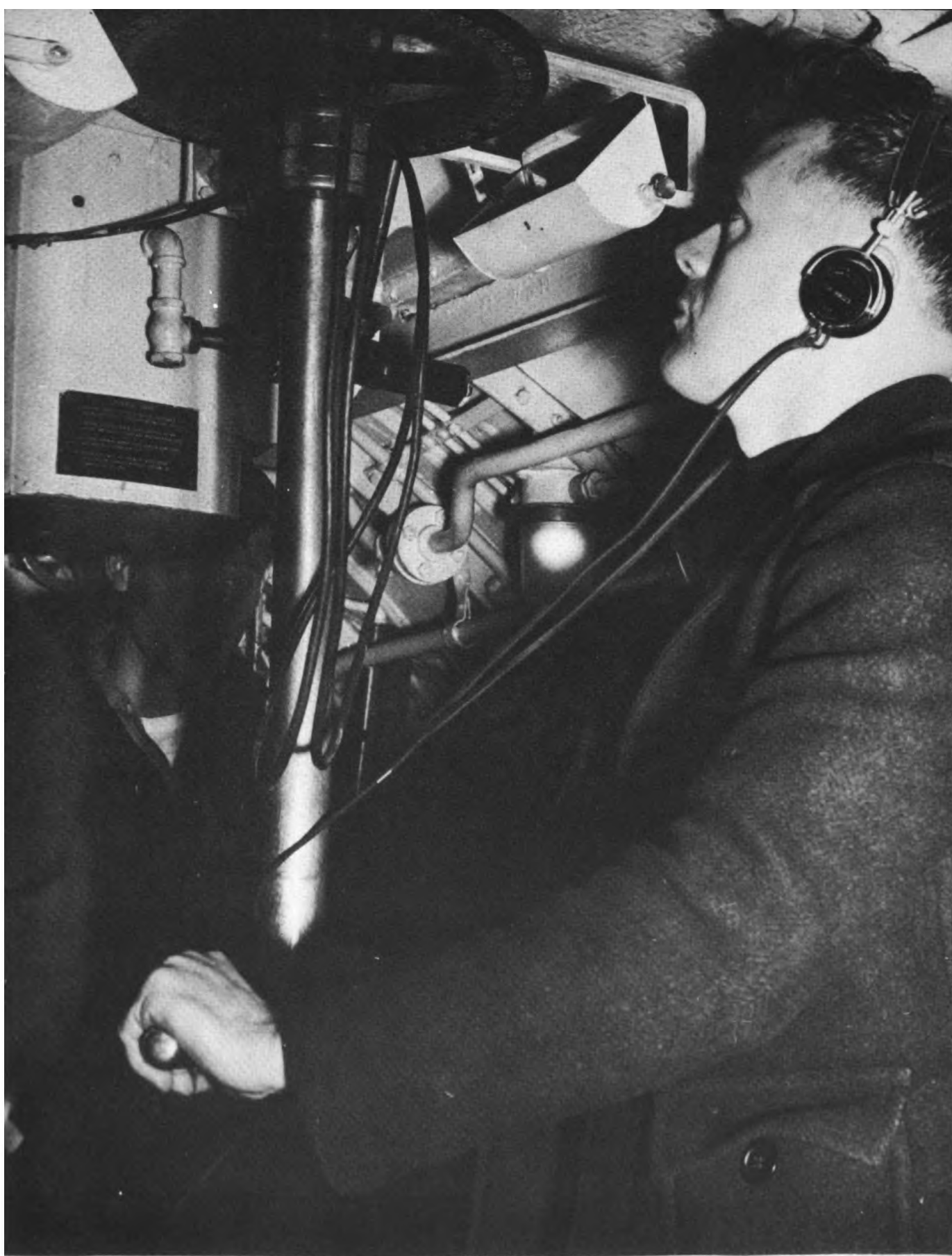
as revealed in the movement of their ships. Such scouting also gives information on the location and strength of enemy units, enabling a friendly force to make swift, unexpected attacks.

An assignment such as this is full of tense thrills. Enemy craft, knowing that scouting submarines will be present, are constantly on the hunt for them and are laying traps to catch the unwary raider.

Sensational movies and stories have loved to dwell on the theme of panic in a trapped submarine. In such a situation, no script writer has been able to resist the temptation to introduce hysteria and dramatics. But that isn't the way submarine sailors react. This isn't to say that they don't get scared. Only fools will say they never are frightened. But scared or not, they are disciplined and trained. They have been drilled and practiced in meeting every conceivable situation. They are used to living and fighting in the close confines of a submarine. When the enemy attacks, they fight back. If they can't fight back, and have to sit quietly on the bottom, they match dollars. Every submarine man, much as every other fighting man, has a feeling deep in his heart that he will come out all right, no matter how bad things seem to be going.

Perhaps that feeling stems from our tradition that the ball game isn't over until the last batter is out. Men who in times of peace have blasted a home run in the ninth inning with two out and two strikes on them, or who have seen touchdowns in the last few seconds of a hard game, don't fold up in battle when the enemy is slamming the ball around the park.

Also, the very type of boy or man who volunteers for submarine service, and who is accepted, is not the type to



Martin Sheridan

Often blind, the submarine is never deaf. A soundman picks
up the sound of motors and checks their location.

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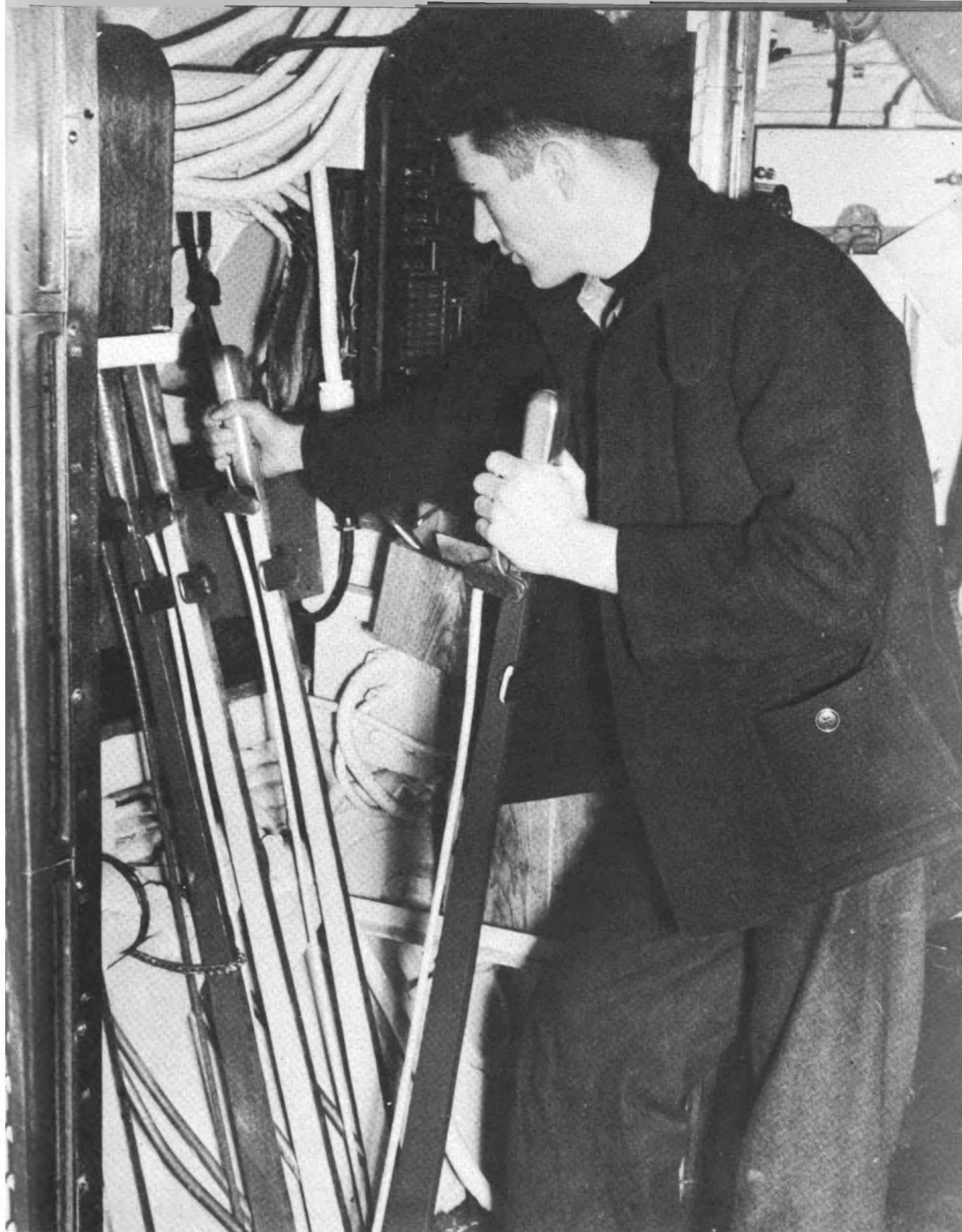
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go to pieces when the going is tough. This quality is not the sole property of submarine sailors. All the boys who have become fighting men are showing the world that in spite of surprise, treachery or superior enemy forces, as long as there is a gun working and a man on his feet, lead will be thrown at the enemy.

But for sheer drama, nothing can match the scene in a submarine when it is stalking for the attack. It may lack the screaming speed of an airplane, or the terrifying power of a battleship or a row of tanks, but it is the chase and the hunt on a scale that is similar to big-game hunting on a greater, more complex scale. Submarines track down the enemy in the vastness of the sea as inexorably as any hunter ever stalked his prey. Sometimes a submarine may have to stalk a ship for days before getting in range, and may not even see, for many hours at a time, the ship it is tracking down.

Submarines have to be stalkers of high skill because of their lack of speed. Submerged, the best submarine in the world can make a top speed of only about ten knots. A fast-moving ship can, therefore, if alert, avoid attack by zig-zagging as it steams ahead at full speed.

This speed not only can carry the ship out of the submarine's range, but also enables it to dodge torpedoes that are fired at it. The telltale wake of the torpedo gives enough warning for a fast ship to swing out of the way, unless the torpedo is too close. Therefore, keeping a submarine at a distance is the best defense against it. If the submarine comes to the surface, where its Diesel engines give it more speed, the attacked ship, if it is armed, has an even chance to fight it out with the attacker. If the attacked



Martin Sheridan

It takes a strong arm to operate the levers which regulate the Kingston valves, which admit and expel water into the ballast tanks.

ship is a warship of any kind, it is the heavy favorite over the surfaced undersea vessel in any fight.

So it is that submarines must maneuver in such a way as to get close enough to their target to fire a torpedo, even if the enemy is faster. This is a problem in approach; and approach is much of the battle.

The usual tactic is for the submarine to lie in wait in waters frequented by enemy shipping. Sooner or later, a ship will pass by. If it is a fast ship, and the submarine is in the line of the ship's course, the commander will try to fire his torpedo at such an angle that the oncoming ship will be hit as it passes a certain point. He may try to close the distance between himself and the ship, to better his chances for a hit.

Exposing his periscope as little as possible, the commander figures the ship's position, speed and course; and his officers, knowing the position of the submarine, plot the time and place for a torpedo to be fired in order for it to hit. When this is plotted, the submarine may wait with its periscope down, firing the torpedo according to the way the attack was plotted. Presence or absence of an explosion will let them know how the attack made out. The commander may raise his periscope for a quick look to see how his shot is going, and perhaps order one or more torpedoes fired. In some cases the attack may be made with three or four torpedoes, fired one after the other in a pattern, with the purpose of boxing in the attacked ship so that if it escapes one, it will be hit by another.

Tracking such a fast ship is part skill and part good guessing. The submarine commander may get a good look at the ship, but not be able to attack it. He may, however, have a good idea as to the destination of the ship, and

know that it will not follow a straight course, but will proceed by a twisting, devious route. In this case, the submarine takes the shortest route, trying to make up for its lack of speed, and hoping to arrive ahead of the enemy ship so that it can lie in wait.

This may be a matter of days. It may be that the submarine will not see another sign of the enemy ship, or may get only an occasional glimpse of it crisscrossing the ocean. At any rate, if the commander has figured the other ship correctly, he will arrive first and be in a position to intercept and sink the enemy when he sails by.

Another method of approach and attack, used against slower ships, is to maneuver the submarine until it is running parallel with the ship to be attacked. The advantage of this attack is that by regulating its speed to that of the enemy ship, the submarine men can know the exact speed of the enemy, and launch its torpedo with more certainty of making a hit. As the torpedoes are fired from the nose of the boat, they are aimed with the submarine itself, much as fixed guns are aimed on an airplane.

As the submarine is cruising at periscope depth, it picks up the sound of another ship in the vicinity. By the sound, the ship seems to be a merchant vessel. The commander steps to the periscope and lifts it cautiously, swinging it around to get a look at the surface. He sees one close ship, an armed enemy tanker of about ten thousand tons. In the distance, he sees the small outlines of more ships—transports, cruisers and destroyers—at what seems to be a gathering place for a convoy.

The tanker is heavily loaded, and steaming along slowly. The submarine turns to take the same course, its periscope down, until the speed of the tanker is figured exactly. Then

the submarine pulls ahead, and swings around at right angles to the oncoming tanker. The officer who is plotting the fire control has figured exactly when the tanker will arrive at the spot where it will be hit by a torpedo. Figuring the speed of the tanker, the speed and distance to be covered by the torpedo, the sub's chances of sinking an enemy are good.

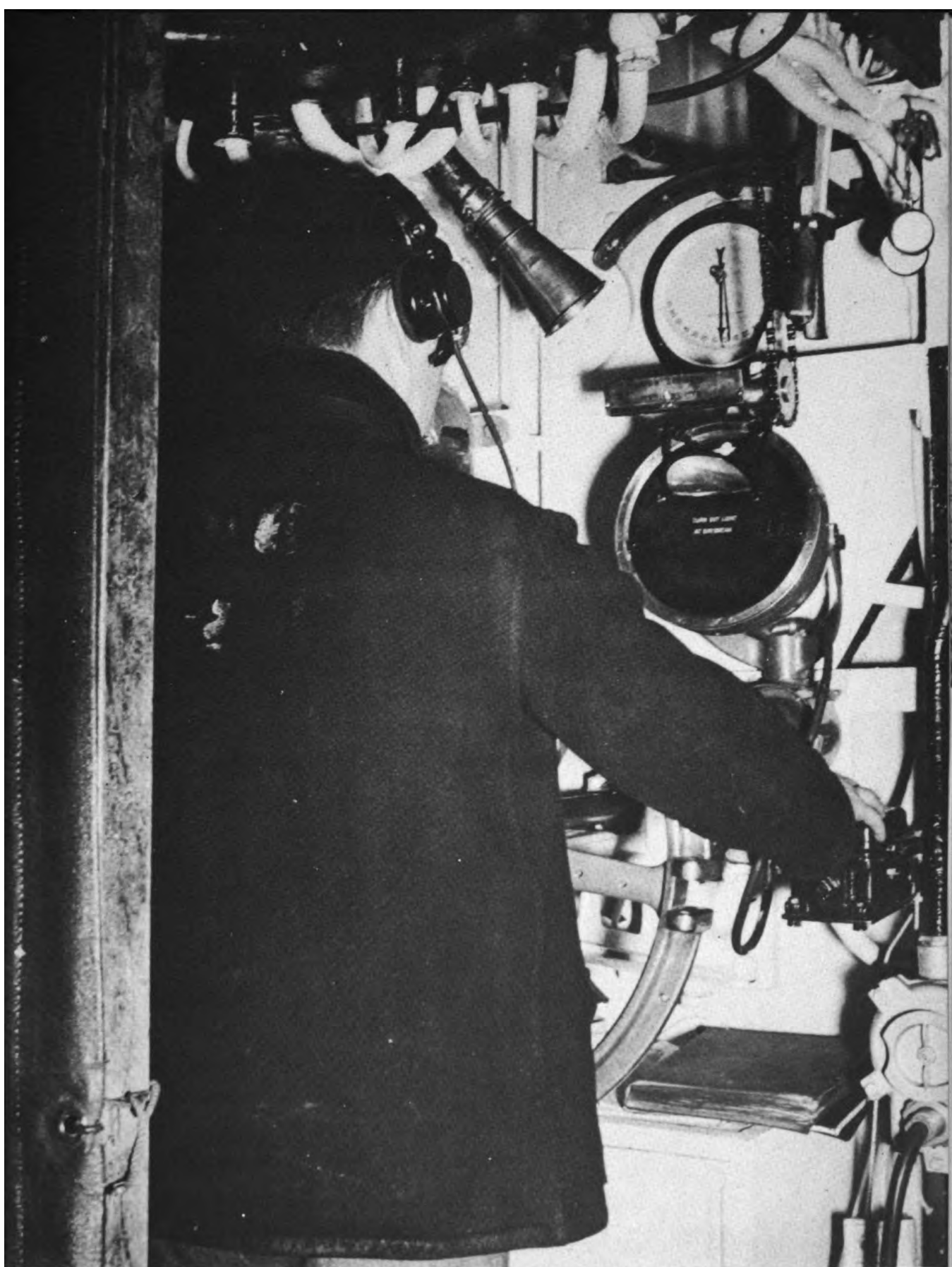
This is a tense moment in the submarine. Every man is at his station, silent and grim. The torpedomen, their torpedoes ready to fire, stand by, waiting for the orders. Suddenly they come. "Fire one. Fire two."

The torpedomen fire their fish. A sound, half explosion, half pop, reverberates as the torpedoes are sped away. Every breath is held while the torpedoes, unseen, are on their way. Suddenly the submarine is shaken by the force of a heavy explosion. The commander looks through his periscope again. The tanker has been hit squarely amidships. Her crew is scuttling around the deck, lowering life rafts and boats. The tanker is already slowly settling toward the bottom. In the distance, lean destroyers are racing for the spot, ready to release a pattern of depth charges.

The periscope comes down. "Take her down to one hundred and fifty feet," the commander orders, giving a new course.

The electric motors hum and whine, and the bow planes grate as they are set for a hard dive. Curving downward and away, the submarine slips deeper into the heavy water, like a giant fish. A few minutes later the commander changes his course again. And then again.

Above, the destroyers are racing back and forth at full speed, dumping tons of depth charges—ashcans—in the area where they expect the submarine to be. The crew



Martin Sheridan

The helmsman steering the boat while it is fully submerged,
getting his orders from the skipper through the earphones.

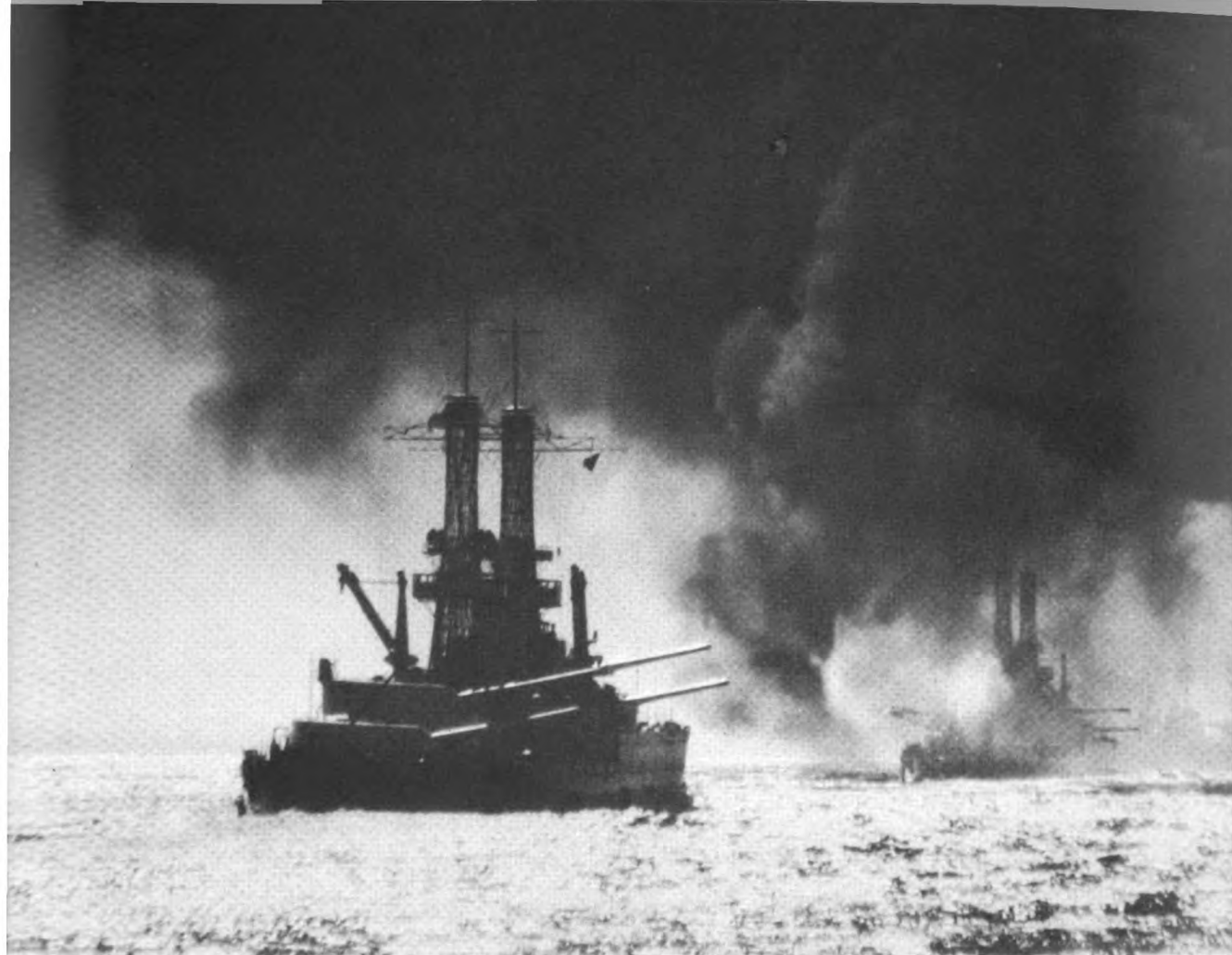
hears the heavy, menacing booms of the underwater explosions, and the submarine shakes from their force. But she is built strongly, and can take a lot of beatings. Driving ahead at full speed, the submarine heads away into the ocean, with another victim to her credit, and important information about an enemy convoy. She may return to attack the convoy, or scout it, or American and Allied planes may make a sudden bombing and aerial torpedo raid. Another episode in the life of the submarine men has taken place.

In addition to scouting and raiding, the submarine has other offensive duties. Laying mines in enemy waters is one. In this operation, deadly mines are laid outside harbors where enemy shipping is heavy, and in any other areas where enemy ships may travel. Although mine-sweepers capture many of these mines, their toll on enemy shipping is extremely high.

Because of its nature, the submarine plays a lone hand even when working with units of the fleet. When two opposing forces are in the same area, and a battle is shaping up, it slips out and scouts the size and strength of the enemy, and aids aerial observers in estimating the force. In actual battle, it gets right into the thick of things, striking telling blows.

As an enemy force advances, destroyers are usually in the lead, screening the carriers and battleships from undersea attack. There are also destroyers alongside the heavier ships, and often, too, they protect the rear.

This is no soft spot for a slow pig boat. To stick up a periscope in the middle of a fleet that is looking for you is a certain invitation to a barrage of bombing and gunning that is designed to punch the sub as full of holes as a Swiss



A battleship as it looks through a periscope, passing fifty feet above the submarine. In actual battle, a submarine this close to an enemy ship would have an easy target. Battleships usually travel with destroyers screening them as a protection against submarine attack.

cheese. Yet a daring commander with a good crew might do just that, because the enemy isn't really expecting a sub to challenge their might. Slipping in between the screen of destroyers, the submarine might have a brief moment to slam out a few fish against a capital ship, and even make an escape in the general confusion.

When the two surface fleets are going at it hot and heavy, the submarine also has its duties. If the enemy is getting the upper hand, and its own ships have to retreat, the submarine tries to pick off the attacking ships and divert them.

If the battle seems to be going to the friendly force, and the enemy has to retreat, the submarine has another job. She then sails to the rear of the enemy fleet, along the probable line of retreat. If they come back that way, battered, fleeing and in disorder, the submarine knives in to pick off any of the escaping enemy warships.

Undersea craft are also useful when it comes to landing spies on enemy shores, or picking them up for the trip home. Naturally, we do not hear of where and how our own boats are acting along enemy coasts; but we do know that German spies and saboteurs have been landed in this country by Nazi submarines.

An airplane could not do this without being detected. And although the men were caught, the submarine was able to bring them right to American shores and get away again.

Although the submarine is primarily an offensive weapon, it is also used defensively. Their patrols off our coasts have as their object the location and destruction of enemy submarines. Our boats operate in waters frequented by the enemy, and are just as hard to locate as are his. Where the

enemy would see and flee a surface ship, another submarine can approach and attack. Duels between submarines are rare, but the very presence of our pig boats is one more thing to keep the enemy harassed and constantly hunted and pressed.

But as well as knowing how the submarine attacks, the sailor has to know how it is attacked, and what defensive methods are employed against it.

Speed is one method by which surface ships escape the submarine. Other merchant ships are armed with deck guns, and have conquered raiders that got within range. Convoys in which merchant ships are taken to their destination by a guarding force of warships have also proved effective.

All warring countries also use air patrols to scour shipping lanes. Occasionally airplanes find an enemy submarine surfaced, and are able to attack before it can submerge. In clear water, even when submerged, one can be spotted from the air in a hundred feet of water.

The most effective weapon yet used against submarines has been the "ashcan," or depth charge. It is simple in operation, and does to the undersea raider what the torpedo does to the surface ship, namely, breaks it apart.

The depth charge gets its nickname from its appearance. It is about the same size and shape as a large ashcan, and is propelled by a Y-gun, which does nothing more than toss the charge clear of the ship that carries it. Depth charges can even be rolled off the stern of a ship.

The big cans contain several hundred pounds of TNT, and are set off by the action of a hydrostatic valve. Thus they can be adjusted to detonate at any depth desired by the pressure of the water.

The exploding depth charge, deep in the water, imparts a terrible punch, which is actually delivered by the water itself, striking like a multi-ton hammer. The unlucky submarine that gets in the way of a charge is literally broken apart by the heavy blow.

In order to be effective against the strongly built under-sea boats of today, the charge must be heavy, and it must explode fairly close. To increase the effectiveness of this method of attack, surface ships try to box the submarine in between a number of depth charges, where the action of the combined explosions will converge to crush the submerged boat.

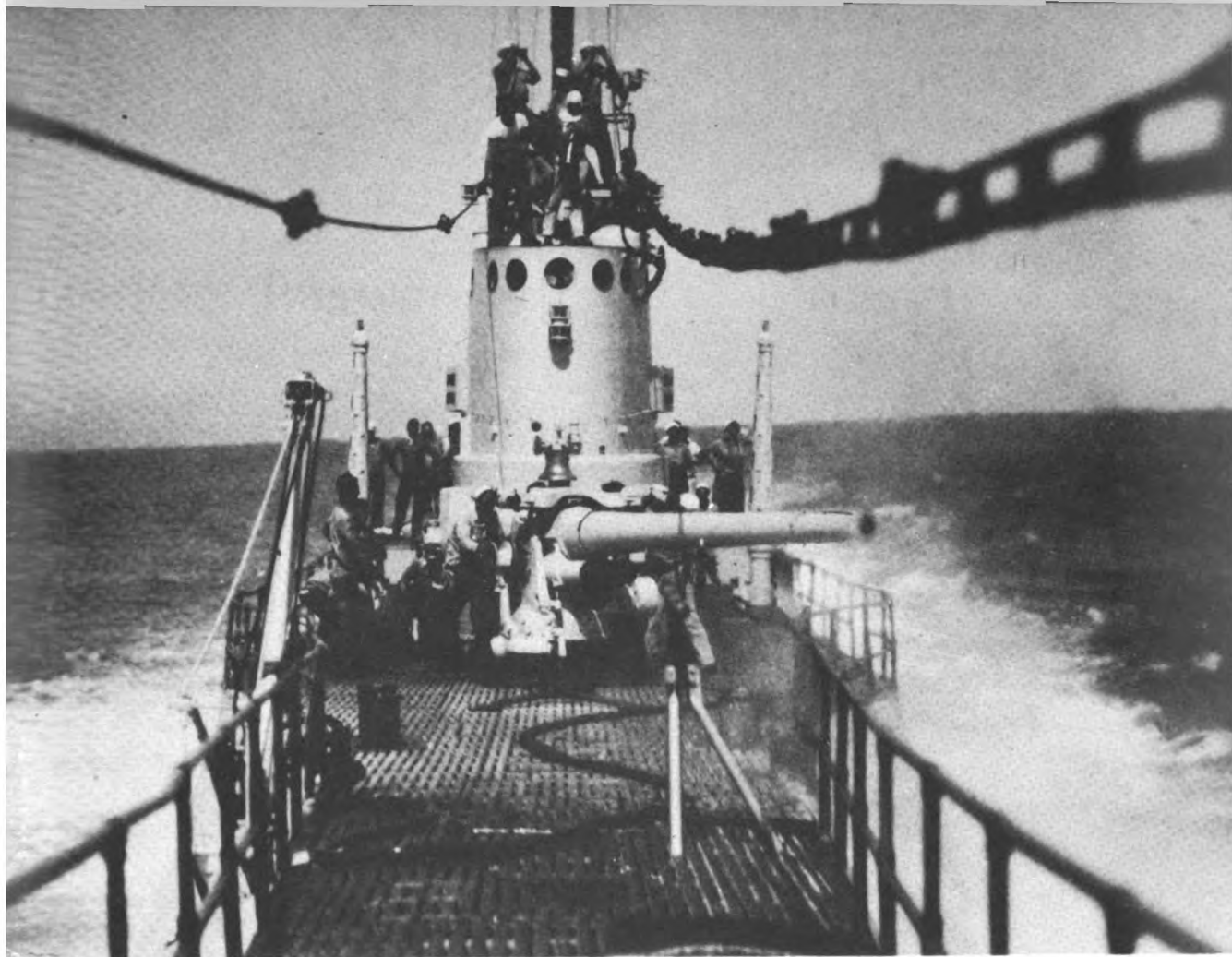
The exact amount of force needed to disable a submarine by a depth charge varies with the construction of the boat, the strength of the charge and other factors.

When attacked, the submarine goes down fast. Even when it is fully surfaced, it can completely submerge in a matter of seconds, with all ballast tanks taking water, and the motors driving it down.

It is also apt to find more safety if it can remain below the depth at which the charges are exploding. The deeper the water, the greater the pressure, and the greatest force of the explosion will be carried in the direction of least resistance, which is toward the surface.

When a depth charge bursts below a submarine, it can practically blow the boat out of the water. Attacking surface ships are also equipped with listening devices to catch the sound of the submerged boat as it tries to escape. That is why it is often a tactic for the submarine to lie quietly on the bottom, hoping the surface ships will lose the trail.

Anti-submarine nets are also used extensively. These nets are stretched across the mouth of a harbor, and are



Manning the deck gun on a submarine in tropical waters. Because torpedoes are large, precious and hard to replace, submarines use their deck gun to attack when they can do so from the surface. A few well-placed shells from this powerful deck gun can send an enemy craft to the bottom with quick efficiency.

designed to keep submarines from entering and making a surprise attack on moored ships, which would be easy targets.

A good net is an effective barrier, although care must be exercised to see that the enemy does not learn where the gaps may be that allow shipping to go in and out, lest he slip through.

He has been at sea for weeks. He has not seen the sun since the day he left port. Although he is in good health, he is dehydrated, his skin is white, and he has lost a little weight.

And now, his boat is heading toward home. New sailors and new vessel alike are now veterans of the war. The submarine is dented and scarred, but the little row of torpedoes painted on the conning tower show the score of enemy ships sent to the bottom.

The sailor has a beard now—the first in his life. It isn't very long, because he isn't very old, and it is smooth and silky—"peach fuzz" it's called by the older hands who take pride in their bristling whiskers.

In these few weeks he has lived in a constant shadow of violence. But as he looks back at the trying days and nights, he realizes that he was never really desperately scared. Even when the depth charges were kicking the boat around like a football, and he hung on grimly, he had that strange, unshakable faith common to all submarine men that he would come out of it all right. "Some of us call it faith in God, and some of us don't mention names," he'll be saying later, when he is on shore. "It doesn't matter what you call it, it's there. We all seem to know that we're going to come out on top. When you're down there on the bottom, like a



A long, lean, hard-hitting raider of the deep, the U.S.S. Grayback, poses for her picture, showing in good detail how the deck and superstructure are mounted on the hull, which is nine-tenths submerged.

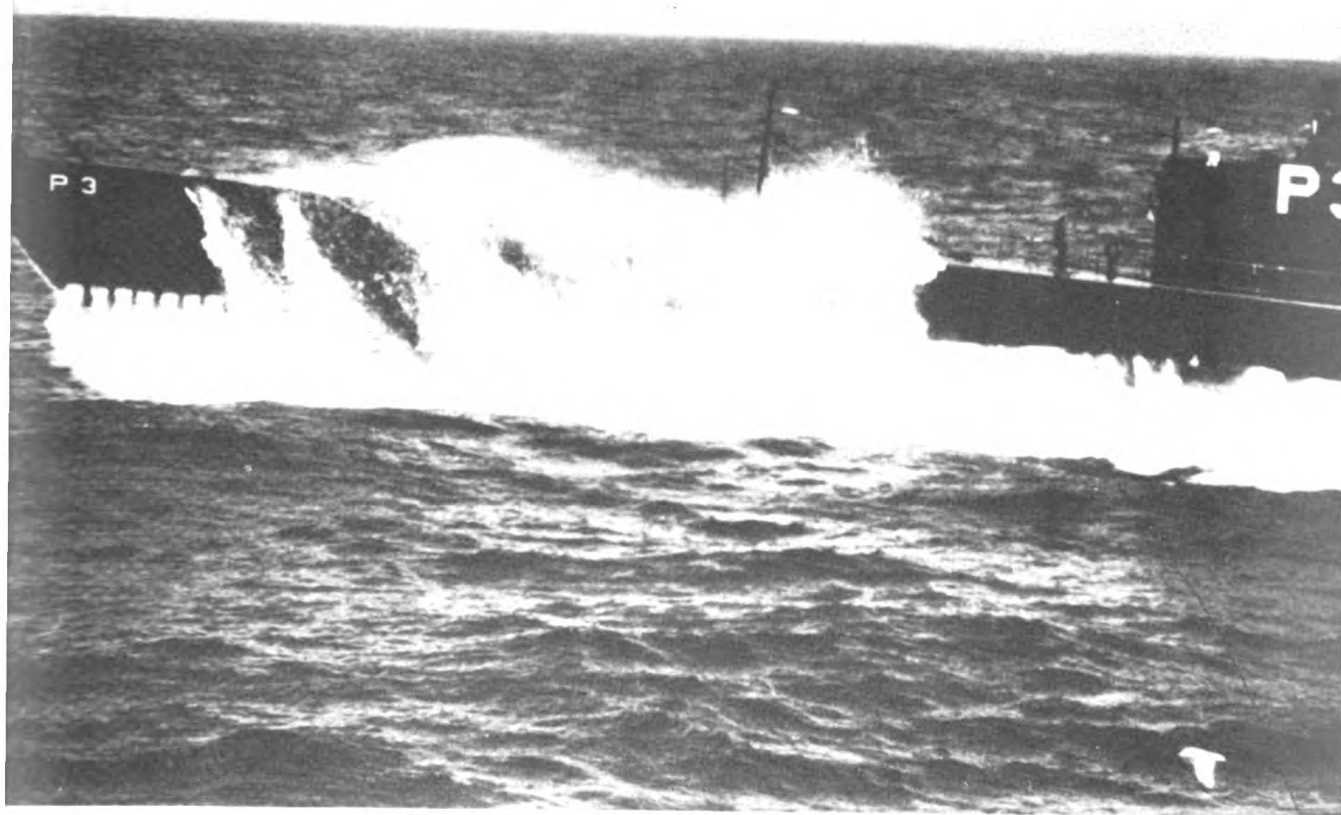
bunch of peas in a pod, you feel a million miles from nowhere. Yet you feel that somebody's keeping a watch over you, and that your turn hasn't come."

As the submarine turns homeward for a well-deserved rest, the sailor thinks of the battles and the victories. He remembers the strain of keeping steady and calm when the enemy was in pursuit, and the yells and cheers when one of the fish he helped launch hit home. He knows what it means to hunt—and to be hunted.

He knows the powerful loneliness that sometimes gripped him when he awoke in the middle of the night and listened to the low hum of the motors as they drove on beneath the sea, and how he had sudden, overpowering longings to see the earth once more, to mingle with thousands of people on a busy city street, and hear the music of auto horns and trains, and the sound of a horse's hoofs thudding in the dirt.

He knows also the closest friendships of his life. He has a fierce, unshakable belief that his skipper is the best in the service, his pig boat the best ever built, and his fellow crew members the best that was ever assembled. He has learned to hate the enemy and the things the enemy stands for. In fighting for his own country he has grown to love it more; and its ideals and principles, which he has defended in the heat and smoke of battle, are more than words. They are a part of him, and he a part of them. The struggle for democracy and freedom has been translated into terms of blood and steel.

And now he's heading for home, a veteran of undersea fighting. On the last night, true to tradition, he sits around with the others who are off watch, drinking coffee and "shooting the breeze."



The *U.S.S. Shark* breaches the surface with the water frothing out of her ballast tanks like long white teeth.

"First thing I'm going to do is get down on my knees and grab two big handfuls of dirt," he says, "just to make sure it's really there."

"You'd better get some dark glasses first," advises an older hand. "Your eyes aren't used to the sunlight now."

"Remember the time we got jammed in that net?" says another. "Boy, I figured that we were going to be hauled in with the rest of the fish."

"Good thing it was just some fisherman's net."

"Did you see the skipper, though? He never turned a hair. The way he had us ease out of that, you'd have thought we were just practicing maneuvers."

"This isn't the first time he's been in a spot like that. I remember once . . ."

The night grows dim as the stories continue. At last the boat comes to the surface, and with an exchange of signals from the shore, it slips wearily into port, tying up for a brief rest before taking to the sea again.

Shore and liberty are really welcome to this sailor. With his pay in his pocket amounting to a sizable sum, he makes up for all the days at sea when the enemy was far away, the world was quiet, and he felt like going to the movies.

He meets old shipmates of former days, who look at the dolphins he has earned and insist on standing treat. He sits at a corner table with some of the men with whom he has gone through school and battle, and they talk in low tones about some of their experiences.

And soon the abundance of space, the noise and bustle of shore begin to pall on the submarine sailor. He goes to sleep at night missing the whine of the electric motors, the

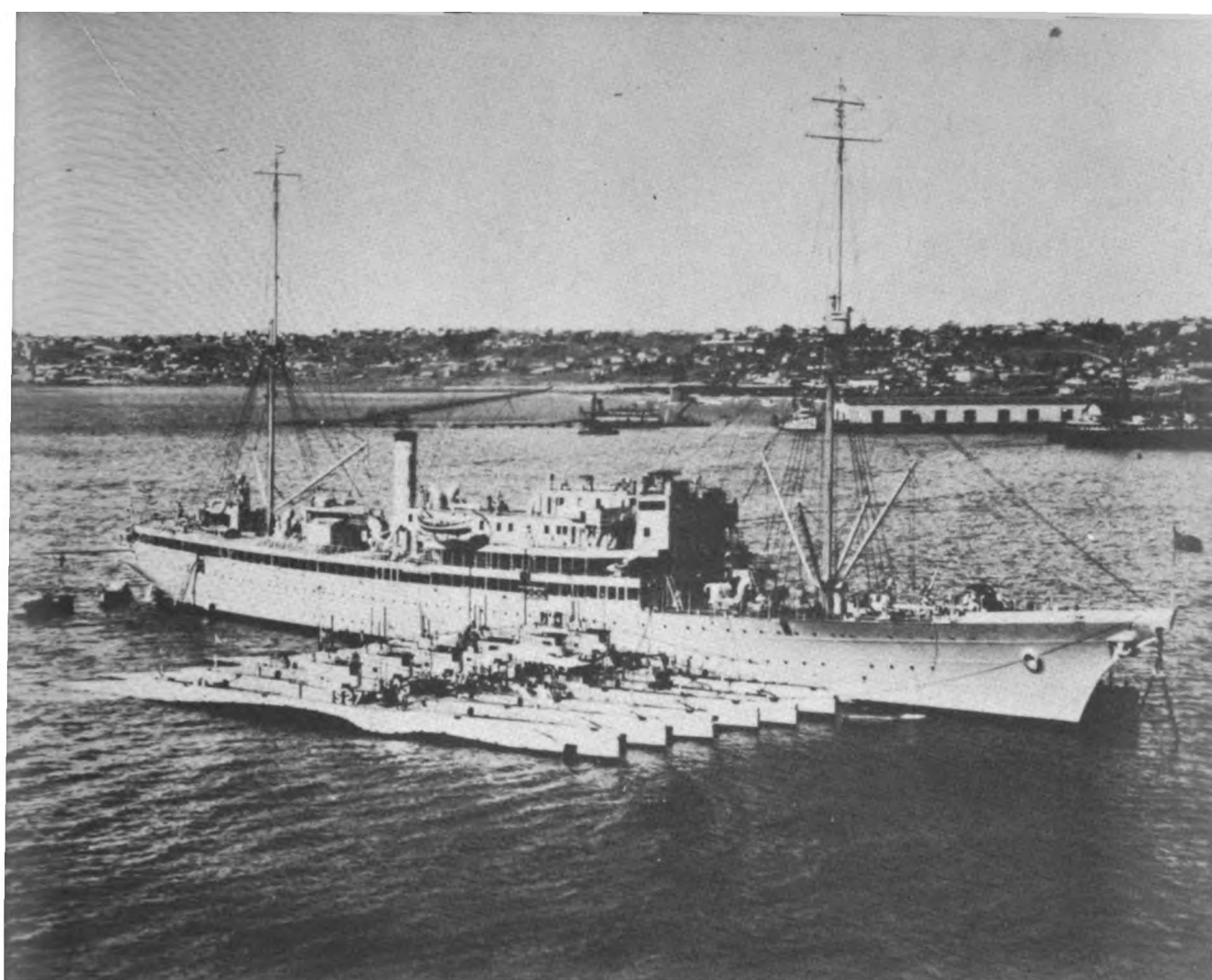


A half-dozen of Uncle Sam's submarines tied up for a rest while the crews enjoy liberty ashore. Submarines such as these have ranged far and wide in the waters of the world, blasting enemy ships out of the water. The periods of strict training and constant practice have justified American methods, men and equipment in the acid test of war.

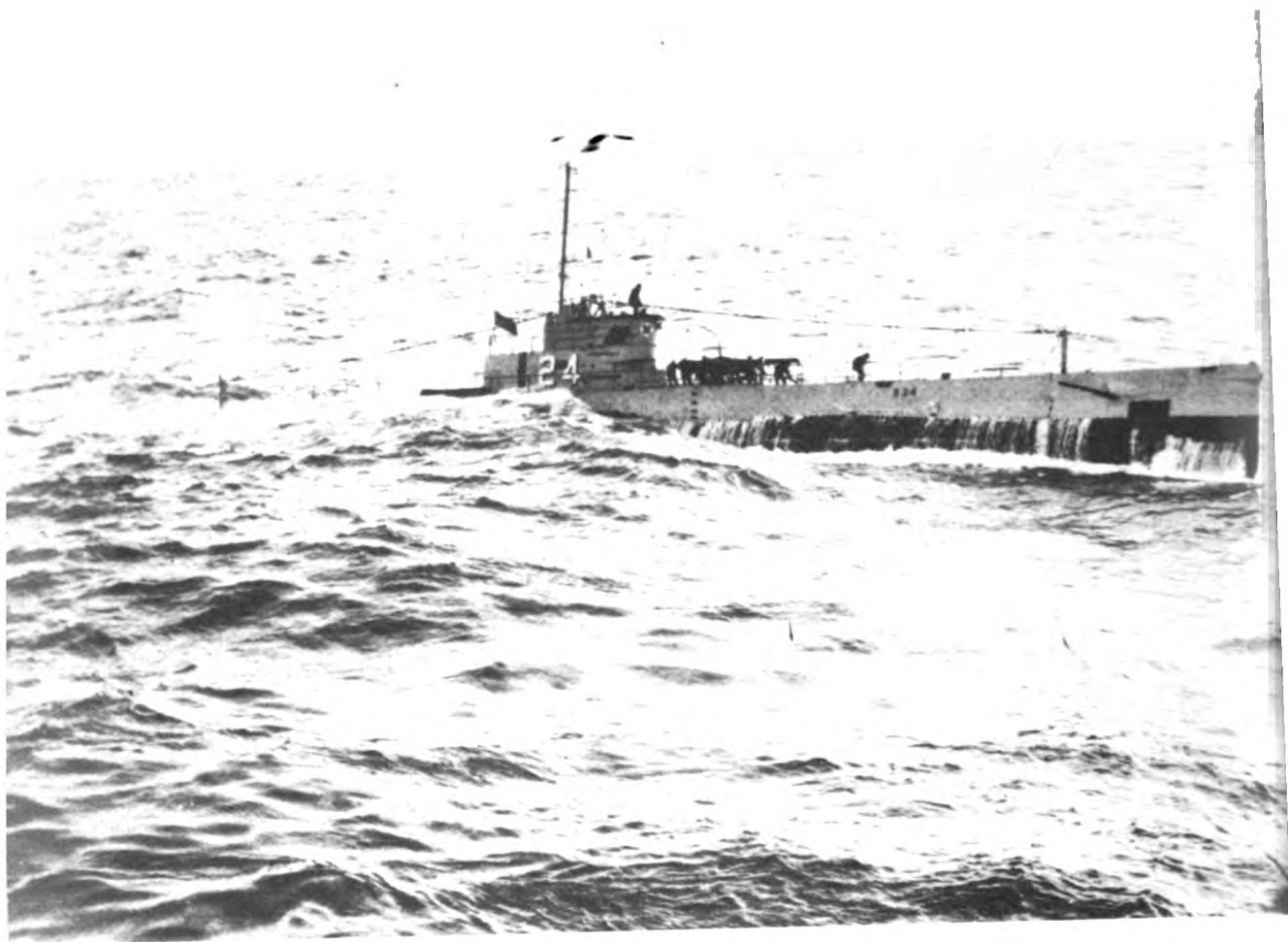
harsh grating of the planes and the sound of water roaring into the ballast tanks.

Happy as he was to step on shore, the submarine sailor is just as happy when his feet hit the submarine deck again, and he goes down the hatch into the boat. He is at home here, among the engines, the pipes, the valves and dials. The bunk he has is tiny, but it is his own. The space in the submarine is limited, but it is his home. He goes about his tasks dutifully while the submarine is based at shore, but he is anxious for the day to come when they will cast off again, to slip into some enemy water with a deadly load of fish, where he will hear the familiar, bawling sound of the klaxon and the commander's even voice giving the order to "take her down."

He is, at last, a true submarine sailor from the top of his Navy haircut to the soles of his Navy shoes.



A submarine tender with her brood is like a proud mother hen with six of her chicks. Tiny as they seem alongside the medium-sized tender, submarines are the terror of the mightiest fighting ships. Tenders are floating bases for submarines when the undersea boats are too far from friendly shores to rely on ports for supplies and repairs.



Running in a heavy sea, the crew mans the deck gun, training to be ready for action at all times, under every condition.

Chapter Six

THE SUBMARINE TODAY AND TOMORROW

THE WAR OF PRODUCTION is being won by the United States. The war of transportation is not such an outstanding victory. In the first six months of 1942, Axis submarines sank nearly three hundred and fifty cargo ships off the coast of the United States.

Three hundred more shiploads of war supplies to Russia last winter might have meant the defeat of the German army. Half that number to Libya would have meant the end of the Nazi threat in that area. One hundred shiploads of war supplies would have meant the defeat of the Japanese in the Philippines.

The war of production can be won, but unless the war of transportation is also won, the war of the battlefield is lost.

It does little good to produce vast quantities of war goods if their final destination is the bottom of the Atlantic. And until the damage inflicted by Axis submarines is combated more efficiently, the war of production may be won, and the others still lost.

Such is the role of the submarine in this war. This is how important submarine warfare is today.

True, our own submarines are carrying the same type of war to the enemy. They have sunk his transports and

freighters, and smashed his battleships. Much of the enemy's production has also ended up at the bottom of the sea.

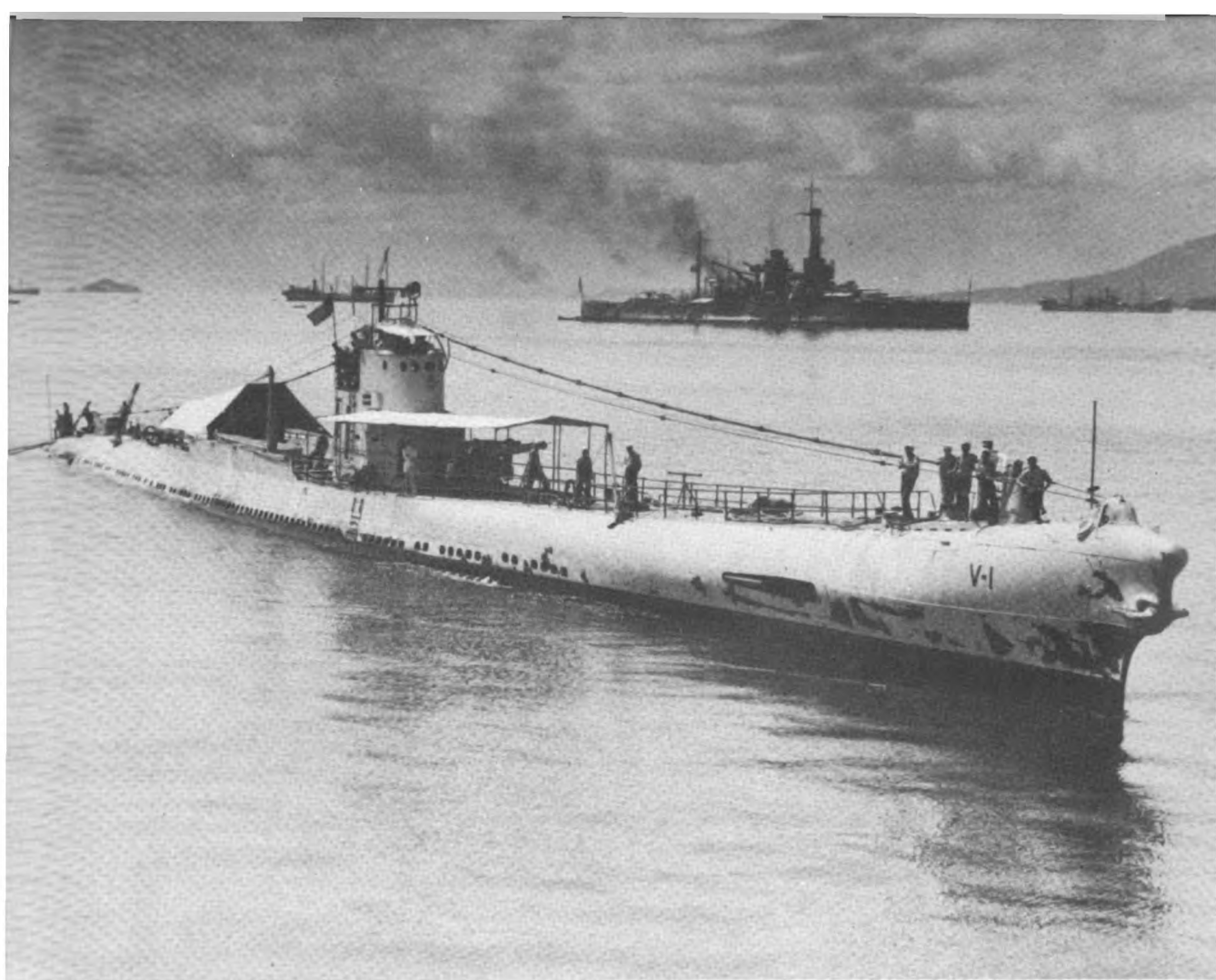
But in this war, the enemy is favored by having more interior lines of communication—lines that are short, protected, and on land. From the factories of Germany and Occupied Europe, it is only a few hundred miles to the Nazi army on the eastern front. From the arsenals of the United States to the fighting Red Army it is a long slow sea haul of as much as 15,000 miles.

To get to any battlefield we must go by sea, and where our ships sail, the enemy submarine lies waiting. At present, it has made the big difference in the war. Submarine successes have enabled the Axis to keep fighting longer than it ever could have if there were no such thing as the submarine.

Submarines are fighting in the war now, and often tipping the scales in favor of one side or the other. Their effect on the outcome of the war will be tremendous.

Advocates of air power as the solution to every problem, from winning wars to how to get along with your wife, have tended to underestimate the submarine because it can't travel 400 miles an hour and doesn't loop the loop. They forget one thing. The great air fleets which will blow Germany and Japan off the map are still on the paper of best-selling books. They fly only in the minds of their creators. Before they can be built, this war will be won or lost with the weapons which are now being produced, and with the machines of war that are now fighting.

The war will not wait several years to oblige inventors. The Nazis are swinging with all their strength in these



Rest for the weary. After a long period at sea, the submarine returns to its base, where necessary repairs are made, new torpedoes and shells brought aboard, and food supplies stocked. The crew looks forward to days of liberty on shore that will refresh them for the next foray against the enemy. For those on board, canvas awnings provide a welcome shade against the hot Pacific sun.

months, and in these months they will either triumph or go down to defeat.

The setbacks the Japanese have received in the Far East have been delivered by the hands of men who flew the planes and manned the submarines. American and Allied submarines, with little publicity, have been hammering away at the enemy, day after day, softening and weakening him for the blows that are to come.

British submarines, during the recent battle of Libya, did not allow a single supply ship to reach the Nazis for two weeks, and in so doing they gave the battered British army help, because they weakened the Nazis' strength to keep on going.

For our own part, we are increasing the use of convoys, and their record is an excellent one in guarding ships against enemy submarines. Fleets of sub chasers are being built and commissioned to keep the waters along our coast free of subs, and they are going into service now, when they are needed, and they will all help get the materials of war to the battlefields in good time.

It has long been the theory of Simon Lake, the American designer and builder of submarines, that one of the best ways to meet the submarine menace was to construct cargo-carrying submarines. Although it is doubtful that anything will be done along these lines during the present war, Lake's theory is interesting.

He believes that cargo-carrying submarines, being invisible, as are submerged fighting submarines, would have a better chance to ply their trade back and forth across the seas without being spotted by enemy subs or aircraft.

He would build submarines of 13,000 tons which would be able to carry as much as the average surface freighter

now in use. Lake patented a cargo submarine as early as 1900, and during the last war this idea was used by the Germans when they sent their giant submarine *Deutschland* to the United States in 1916, through a British blockade. When she left, British destroyers waited for her outside the three-mile limit, but she eluded them.

Lake believes submarines of this kind, which as troop ships could carry 2500 men, are the real answer to the submarine menace. Perhaps, before the war is over, his ideas may be called into play.

What the role of the sub will be tomorrow, no one knows. As long as there are wars there will be submarines, for they are creatures of war, and among the most deadly of all.

In times of peace, submarines practice for war. If there were to be an era without war or threat of war, they would disappear, for they have no peacetime function.

Submarines and their brave crews will help us win this war as speedily as men and machines can do it. When it is over, the submarine sailors, much as they love their pig boats, will be among those who hope the submarines can be exhibited as museum pieces. There they can serve as a reminder to future generations that to win a world of peace, American boys went under the sea in fighting ships.

LOAN DEPT.

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